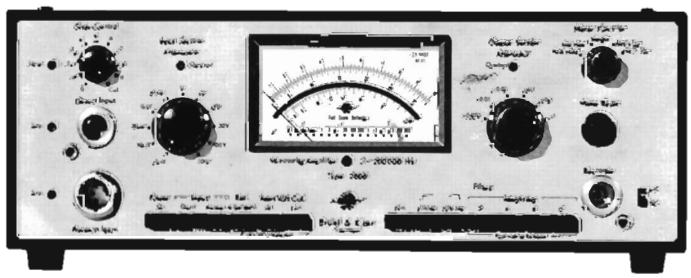
2606

Instruction Manual

Measuring Amplifier Type 2606

A precision mains/battery operated instrument, measuring true RMS levels with an accuracy of 0,5 dB for sound, vibration or voltage signals with crest factors up to 10 (40 for lesser meter deflections). »Impulse«, »Impulse Hold« and »Peak Hold« measurement modes are also included. When used with a B & K microphone it conforms to the IEC Recommendation 179 for Precision Sound Level Meters and the proposed extension to this standard for Impulse Precision Sound Level Meters.



BRÜEL & KJÆR

033-0013

MEASURING AMPLIFIER
TYPE 2606

This manual applies for instruments after serial number 454879

June 1973

CONTENTS

Low-Noise Measuring Amplifiers

FEATURES 2608

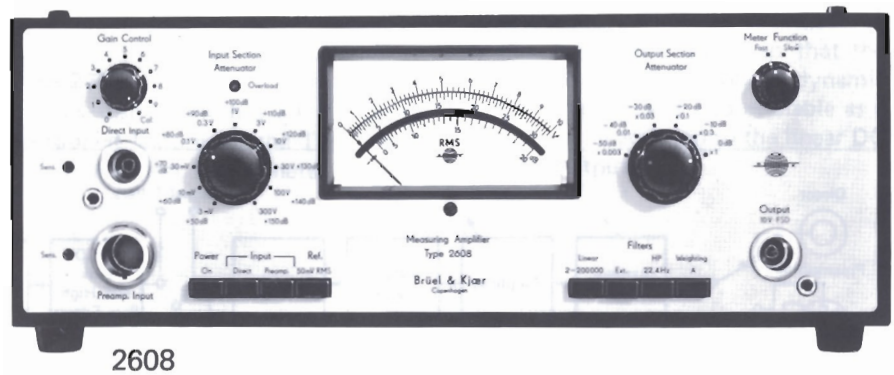
- Frequency Range 2 Hz to 200 kHz
- Measuring Range 10 μV to 300 V RMS FSD
- Accurate RMS indication for crest factors up to 5
- Fast and Slow meter damping
- Sockets for external filters
- A-weighting network
- AC output signal

ADDITIONAL FEATURES 2606

- Impulse sound measurement to DIN standards
- Maximum RMS hold circuit
- Interchangeable meter scales
- Accurate RMS indication for crest factors up to 40
- Range settings displayed on meter scale
- A, B, C and D-weighting networks
- Overload indication on input and output
- Mains or 12 V DC supply
- AC or DC output signal

ADDITIONAL FEATURES 2607

- Indication of + Peak, −Peak and Maximum Peak levels
- Peak indication for impulses with only 20 μsec rise time
- Adjustable decay time for Peak measurements
- Adjustable averaging time for RMS measurements
- Lin to Log converter for logarithmic meter deflection
- Dynamic range up to 60 dB at DC output
- AC, DC and logarithmic DC output



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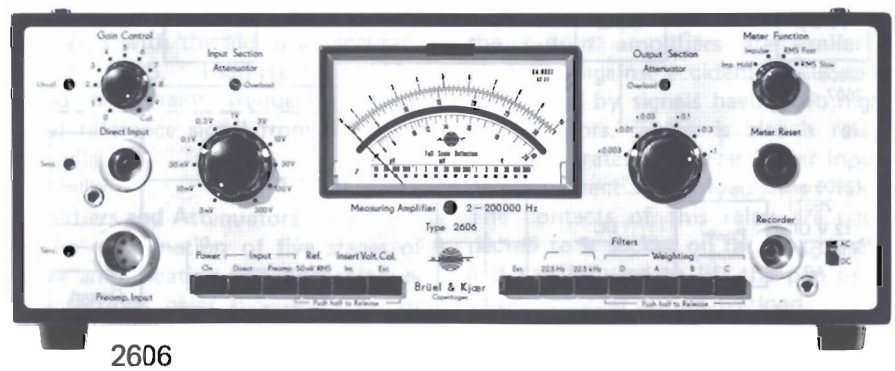

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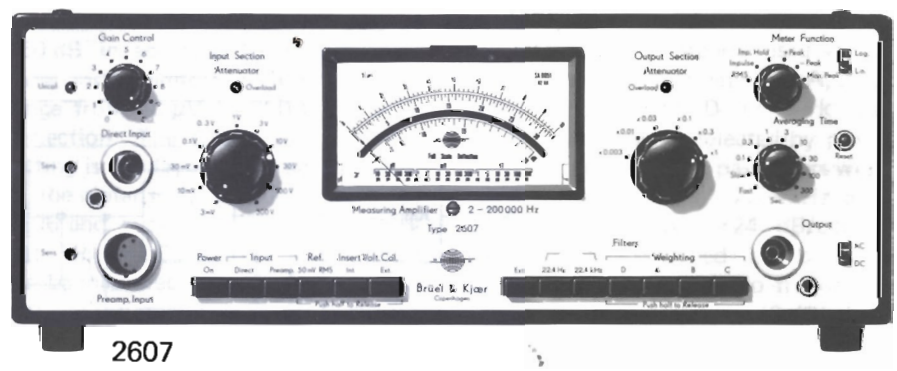

2607

USES:

- Precision sound and vibration measurement with B & K condenser microphones, accelerometers and other vibration transducers
- Measurement of short duration signals
- Frequency analysis with B & K band pass filter sets
- Measurements requiring a wide band electronic voltmeter
- As a high gain, low noise general purpose amplifier

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The Measuring Amplifiers Type 2606, Type 2607 and Type 2608 are extremely versatile instruments which form the basic measuring element in numerous sound and vibration set-ups. When used with a B & K condenser microphone system, they constitute a Precision Sound Level Meter in accordance with IEC, ANSI and DIN requirements. The 2606 and 2607 also conform to DIN and the proposed IEC Recommendation for Impulse Precision Sound Level Meters (Instruments which meet "Impulse" requirements also, explicitly meet "Precision Sound Level Meter" requirements). Accurate vibration measurements are made using B & K accelerometers and other vibration tranducers.

The instruments employ solid state electronics to give accuracy and repeatability of measurement. Calibration is simple and has excellent long term stability. The Measuring Amplifiers combine a wide measuring range with low noise, laboratory accuracy and easy operation, and although essentially similar, they incorporate different features to suit varying measurement requirements.

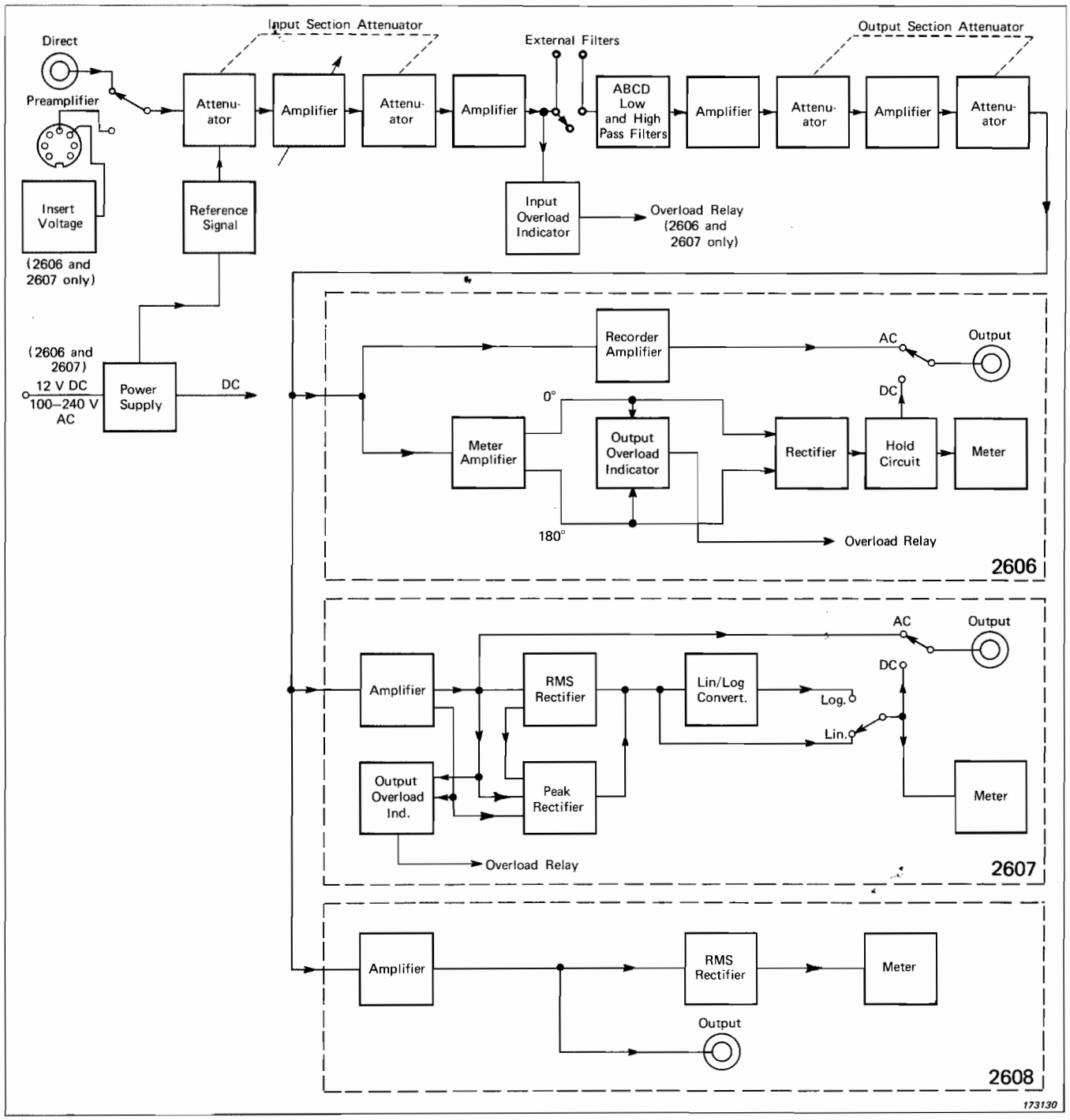


Fig.1. Block Diagram of Type 2606, Type 2607 and Type 2608

Type 2608

This is a simplified model with relatively few features, and is intended primarily for use in compressor feedback circuits, in the less demanding sound and vibration set-ups, and as an accurate voltmeter or calibrated amplifier.

Type 2606

With a full range of sound level weighting networks, a meter hold circuit and a high crest factor capability, the Type 2606 is well suited to comprehensive sound and impulse sound level measurement. Interchangeable meter scales are provided which enable direct reading of many sound and vibration parameters, and the ability to operate on a 12 V DC supply frees the instrument to perform measurements of laboratory accuracy away from mains power. AC or DC signal output may be selected for use with level recorders, DC is primarily used for recording with meter response "Impulse".

Type 2607

This instrument has all the above mentioned features of the Type 2606, but in addition has a meter rectifier that gives true reading of + Peak, –Peak and Maximum Peak levels for measurement of very short duration signals (>20 μsec). Adjustable time constants in both Peak and RMS rectifiers allow selection of averaging times to suit a particular signal, for example, long averaging times are needed for accurate measurement of low frequency signals. A linear to logarithmic converter provides an analog logarithmic signal so that the meter can cover a full 50 dB dynamic range. This signal is also available as a DC output in addition to the linear DC and AC outputs.

Description

The Measuring Amplifiers are basically low noise, wide range calibrated voltmeters and have many common components, the main differences being in their rectifier circuits, see the block diagram in Fig.1.

Input

Two alternative inputs are provided: "Direct Input" fitting B & K coaxial plugs, used for voltage and vibration measurement, and "Preamplifier Input" fitting the seven pin plugs of B & K microphone preamplifiers and the Type 4292 Accelerometer Preamplifier. This socket supplies the stabilised voltages for the preamplifier, and the 200 V polarisation voltage for condenser microphones. The socket can also be used with the Power Supply Adaptor ZR 0024 to give the 28 V DC needed for some vibration preamplifiers.

In addition, a 1000 Hz signal is available from the Preamplifier socket of the 2606 and 2607. This is used with the B & K Type 2627 Microphone Preamplifier for Insert Voltage Calibration of microphones according to IEC R 327 and ANSI S1.10 – 1966.

A continuous –10 dB to + 4 dB range of sensitivity adjustment is available from screwdriver operated potentiometers on the front panel for each input. These adjustments, which control feedback in the first amplifier stage, facilitate meter scale calibration for a wide range of transducer sensitivities.

The Measuring Amplifiers are easily calibrated with the aid of an accurate 50 mV RMS, 1000 Hz sinusoidal (2608 has mains frequency square wave) reference signal from the built-in oscillator.

Amplifiers and Attenuators

The combination of five stages of signal amplification and two attenuation sections gives high linearity of amplification with low noise and distortion. Overall amplification of 120 dB (114 dB for 2606 to allow for crest factor 10) and attenuation of 150 dB in accurate 10 dB steps give these instruments a voltage measuring range from 10 μV to 300 V full scale deflection. The combined attenuator setting is displayed by indicator lamps on the meter scales used with the Type 2606 and Type 2607 to simplify readout. Up to 500 V RMS, 700 V Peak can be measured by using the gain control potentiometer to lower the sensitivity of the input stage. Signal to noise ratio is better than 80 dB for input signals higher than 30 mV.

Overload Indication

When used in the linear mode, overloading of the input amplifier can be estimated from the meter deflection. However, when weighting networks are used or external filters inserted, overloading caused by signal components outside the passband will not be seen on the meter. Therefore the amplifier has an overload warning lamp that lights if the amplifier is overdriven.

In the Type 2606 and Type 2607, the output amplifiers are similarly protected against accidental overloading caused by signals having too high crest factors. There is also a relay which operates whenever either input or output section overload lamps light. The contacts of this relay are connected to a socket on the rear panel, and can be used to lift the pen of a Level Recorder during overload.

Filters

In the Type 2606 and Type 2607, the internationally standardised sound level meter weighting networks A, B, C and the proposed D network are built-in and may be selected by push-button. Low and high pass filters with cut-off frequencies of 22.4 kHz and 22.4 Hz and slope >24 dB/octave can also be switched in to limit measurement to the audio frequency range. A fixed 315 kHz (3 dB) low pass filter with >18 dB/octave slope ensures well defined upper frequency limits for the amplifiers at any attenuator position. Fig.2 shows the frequency characteristics for the various filters. The Type 2608 has push button selection of only the A-weighting network or a high pass filter with cut off frequency 22.4 Hz and slope >18 dB/octave.

External filters can be connected to all Amplifiers, and can be used either in the linear mode or in series with one of the internal filters thus facilitating frequency analysis of weighted signals.

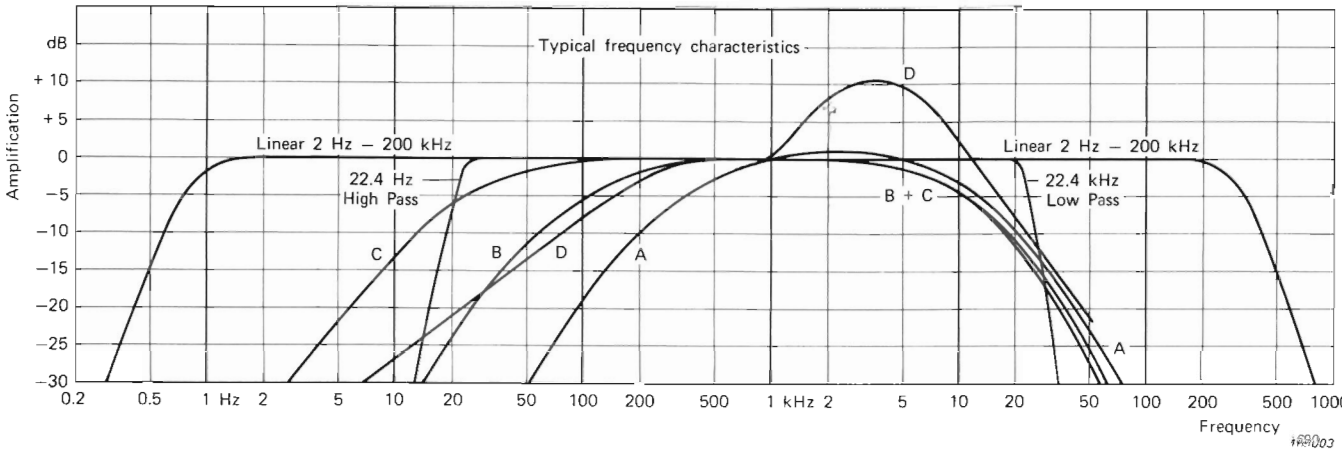


Fig.2. Typical frequency characteristics showing the built-in filters and weighting networks

RMS Rectifier, Type 2608

In this instrument the RMS rectifier circuit gives true RMS response, accurate within ±0.5 dB for signals with crest factors up to 5. The true RMS reading is obtained by approximating the square-law curve by means of straight line portions.

The built-in averaging times "Fast" and "Slow" are in accordance with IEC, ANSI and DIN Recommendations for Precision Sound Level Meters.

RMS Rectifier with Impulse and Hold, Type 2606

The RMS rectifier circuit of this Amplifier gives true RMS response, accurate within ±0.5 dB for signals with crest factors up to 10, and accurate to ±2 dB for crest factors up to 40 at reduced meter deflection. The built-in averaging times "Fast" and "Slow" are in accordance with IEC, ANSI and DIN recommendations for Precision Sound Level Meters.

For impulse sound signals the RMS level is measured with a rise time of 35 msec and a decay time of 3 seconds according to the requirements of DIN and the proposed IEC Recommendation for Precision Impulse Sound Level Meters. An "Impulse Hold" circuit is included for convenient measurement of transient signals and single events. A meter reset push-button is also provided.

RMS and Peak Rectifier with Impulse and Hold, Type 2607

Both RMS and Peak values of a signal can be measured with this instrument which gives accurate reading of all commonly encountered random, quasi-random, periodic and complex waveforms. The dynamic range for the output signal, when used in RMS mode is 60 dB for a signal with crest factor of 1.4 (Sine). For peak measurements the dynamic range is 50 dB. Averaging times from 0.1 to 300 sec. can be chosen manually or remotely, for measurement of low frequency signals, as well as "Fast" and "Slow" according to IEC, ANSI and DIN Recommendations for Precision Sound Level Meters.

For impulse signals the maximum RMS level is measured with a time constant of 35 msec according to the requirements of DIN and the proposed IEC Recommendation for Impulse Sound Level Meters. The accuracy is ±0.5 dB for signals with crest factors up to 5. A maximum RMS hold is provided to facilitate measurement of transient signals.

Positive, negative, and maximum peak measurements can be performed over a dynamic range of 50 dB. The rise time is 20 μsec, then the signal is held at its maximum level for 400 msec, after which preselected decay times are available between 0.1 and 300 seconds. Signals with a duration as short as 20 μsec can be measured accurately in this way.

If necessary, fixed resistors or a potentiometer can be connected to the Averaging Time socket on the rear panel (see Fig.3) to give different Peak decay times. Under these conditions the 400 msec Peak measurement, hold circuit is not in operation.

When the "RMS" mode of measurement is in use, the meter deflection and DC output voltage can be reset to zero using either the Reset button on the front panel, or remote control via the Averaging Time socket. The averaging time is 100 msec. In "Impulse Hold" or one of the "Peak" modes, the push button gives a decay time of 100 msec. With "Impulse Hold", remote reset gives a decay time better than 70 msec, while in "Peak" mode, the decay time is 10 msec, which permits the high scan rates required in automatic monitor and control systems.

Output

An output terminal on each of the Measuring Amplifiers is provided for

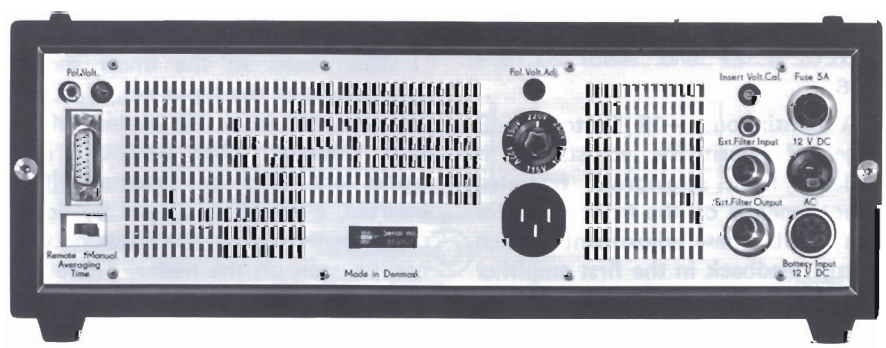


Fig.3. Rear Panel of the Type 2607

connection to recording instruments such as the Level Recorders Type 2305 and Type 2307. The Type 2608 has provision only for AC output while Types 2606 and 2607 give the option of AC or DC output selected by a switch on the front panel. The Type 2607 also has a built-in linear to logarithmic converter that provides a DC voltage at the output proportional to the measured dB value, which gives a linearly graduated meter scale covering 50 dB. A dynamic range up to 60 dB (in "RMS" mode) is available at the DC output.

Meter Scales

The Type 2608 has a non-interchangeable meter scale that is calibrated for direct reading of voltage and sound level. The 2606 and 2607 are supplied with interchangeable meter scales to facilitate direct reading of voltage and decibels with linear or logarithmic graduation, sound level with one inch, and with half inch microphones, and acceleration with 6 to 17 mV/g accelerometers. Scales can also be supplied for measurement of absorption coefficient, power spectral density, dBm, and for use with 1/4 inch and 1/8 inch microphones. Blank scales are available, and other scales can be made to order.

Power Supply

Each Measuring Amplifier can be powered by mains supplies from 100 V to 240 V AC, 50 to 400 Hz. In addition, the 2606 and 2607 can be powered by a 12 V DC supply, and thus can be used in the field powered from batteries, to give measurements of laboratory accuracy. Power consumption (of the 2607) is approximately 33 Watts from mains and 31 Watts from batteries.

Examples of Use

Measuring Amplifiers Type 2606, Type 2607 and Type 2608 can be used alone for precision voltage measurement or as amplifiers where calibrated gain is required. They can also be used with an extensive selection of accessory equipment to facilitate comprehensive measurement in acoustics, electroacoustics, and in the shock and vibration field.

External filters can be connected and used alone or in series with the built-in filters. Type 1614 and 1615 Band Pass Filter Sets can be used for third octave and octave analysis, these are particularly useful in the analysis of sound and vibration. Psophometer Filters ZS 0301 and WB 0071 are used for measurement of noise in program transmission and commercial telephone systems. The Type 2020 Heterodyne Slave Filter has constant bandwidth, and when tuned from one of the Signal Generators Type 1022 or 1024 it follows their signal frequency automatically. The set-up shown in Fig.4 is used for constant bandwidth frequency analysis of the signal from an accelerometer. The 2020 is also used with the Measuring Amplifiers in the measurement of power spectral density, mechanical impedance, cross power spectral density and frequency response measurements at low levels. Automatic recording of frequency analyses on calibrated paper is possible with the Level Recorders Type 2305 and 2307 and any of the filters mentioned above. Fig.5 shows a typical set up for frequency analysis and recording of sound levels.

Several instruments are available that consist of a Measuring Amplifier and filter unit built into the same cabinet. For example, the Type 2113 and Type 2114 Spectrometers consist of a Measuring Amplifier and a third octave Band Pass Filter Set, while the Type 2120 Frequency Analyzer is a combination of the Type 2607 and a constant relative bandwidth filter featuring bandwidths down to 1%. Other combined instruments using similar Amplifiers are the Type 3347 Real-Time Third Octave Analyzer and the Type 2010 Heterodyne Analyzer.

A wide range of transducers can be used with these instruments, and the interchangeable meter scales of the 2606 and 2607 enable direct reading with most B & K microphones, accelerometers and other vibration transducers. The B & K condenser microphone range covers frequencies between 3 Hz and 140 kHz and a dynamic range up to 186 dB SPL allowing precision sound level measurements to be made which satisfy the requirements of IEC, ANSI and DIN. The 2606 and 2607 also satisfy requirements for precision impulse sound level measurement. When the Measuring Amplifiers are used with B & K accelerometers, vibration can be measured over the frequency range between 2 Hz and 60 kHz and acceleration levels between 0.000 002 g and several thousand g, and shocks up to 100 000 g.

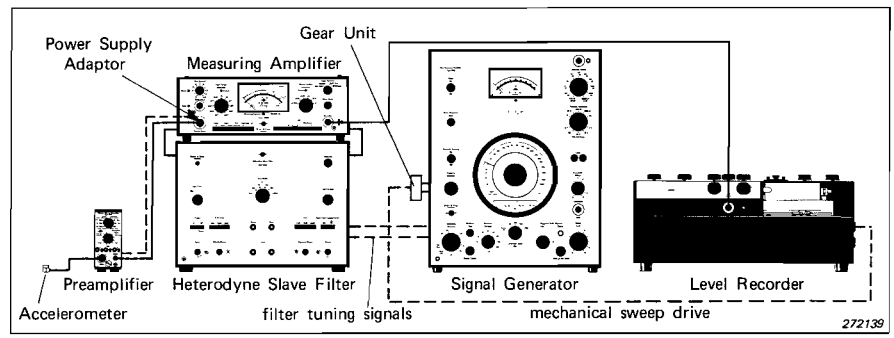


Fig.4. Set-up for constant bandwidth frequency analysis of vibration

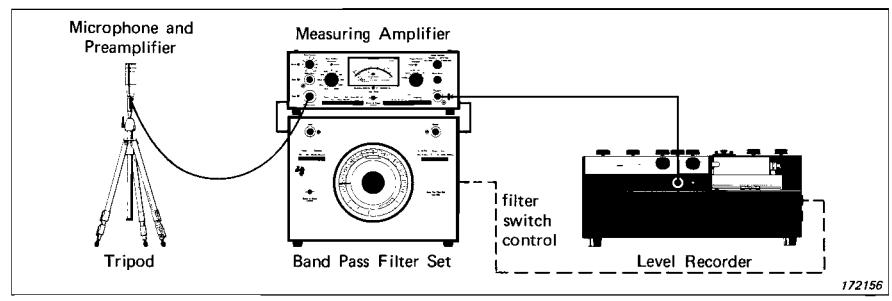


Fig.5. Set-up for 1/3 octave and octave frequency analysis and recording of sound

The Type 2606 is particularly useful for measurement of signals with high crest factors (up to 40), while the Type 2607 with peak rectification is more suitable for measurement of mechanical shock, sonic booms and the evaluation of hearing protection. The long time constants available in the 2607 are for measurement of signals with rapidly changing amplitudes, for example filtered low frequency noise.

Common Specifications 2606, 2607 and 2608

Amplifier Response:

Measuring Range:
10 μV to 300 V RMS for full scale deflection on meter display. Up to 500 V RMS, 700 V peak.

Frequency Range: (Without filters):
2 Hz to 200 kHz ± 0.5 dB re 1000 Hz
10 Hz to 50 kHz ± 0.2 dB re 1000 Hz

Phase Deviation:
± 5° between two instruments in the range 5 Hz to 20 kHz

Total Amplification:
120 dB (2606: 114 dB)

Input:
Input Impedance
DIRECT INPUT:
1 MΩ in parallel with 50 pF
PREAMP. INPUT:
In accordance with B & K Microphone Preamplifiers

External Filters:
Weighting networks or built-in filters may be used in series with external filters.
Output impedance (from Meas. Amp. to Ext. Filt.) < 10 Ω, min. load impedance 500 Ω. Maximum output voltage 5.0 V peak.
Input impedance (from Ext. Filt. to Meas. Amp.) 146 kΩ parallel with 100 pF.

Overload Indicators (adjustable):
Input overload level 5.6 V ± 1 dB (peak).
Output overload level 56 V ± 1 dB (peak). (Not 2608).
Internal adjustment of overload levels is possible.
Lamps light for overload pulse longer than 0.2 msec, remain lit for 0.5 sec minimum.
Relay output of overload function. (Not 2608).

Attenuators:

Input Section:
3 mV to 300 V in 10 dB steps.
Accurate to within ± 0.1 dB at 1 kHz relative to 100 mV position

Output Section:
x 0.003 to x 1 in 10 dB steps.
Accurate to within ± 0.1 dB at 1 kHz relative to x 1 position

Total Range:
0 to 150 dB in 10 dB steps
The measuring range setting (both attenuators) is displayed on the meter scales. (Not 2608)

Polarization Voltage:
The polarization voltage is adjusted to 200 V for Condenser Microphone Cartridges

Input Amplifier:
Nominal 50 dB gain adjustable from 40 to 54 dB.
Distortion < 0.01% at 1 kHz (load 500 Ω).
Hum < 1 μV with input short circuited.

Output Amplifier:
Distortion with 10 kΩ load:
1% for 30 V RMS output voltage.
0.3% for 10 V RMS output voltage.
0.1% for 3 V RMS output voltage.
Hum < 10 μV with external filter socket short circuited.

Cabinet:
Supplied as model A (light-weight metal cabinet), B (model A in mahogany cabinet) or C (as A but with flanges for standard 19" racks).

Dimension (A-cabinet):
Height: 132 mm (5.2 in)
Width: 380 mm (15.0 in)
Depth: 200 mm (7.9 in)

Noise
(typical with maximum amplification and input short circuited):

Instrument and filters, referred to input:

Lin. 2 Hz to 200 kHz	< 7.0 μV RMS
Lin. 2 Hz to 22.4 kHz	< 2.5 μV RMS
Lin. 22.4 Hz to 200 kHz	< 7.0 μV RMS
A-weighting	< 1.5 μV RMS
B-weighting	< 1.6 μV RMS
C-weighting	< 1.7 μV RMS
D-weighting	< 4.0 μV RMS

Output Section noise, referred to input of Output Section:
Lin 2 Hz to 200 kHz < 20 μV RMS

Signal-to-Noise Ratio:
Better than 80 dB for input signals > 30 mV.

Stabilization Time:
10 s.

Operating Temperature:
5° to 40°C (41° to 104°F).

Storage Temperature:
−25° to 70°C (−13° to 158°F).

Humidity Range:
0 to 90% relative humidity.

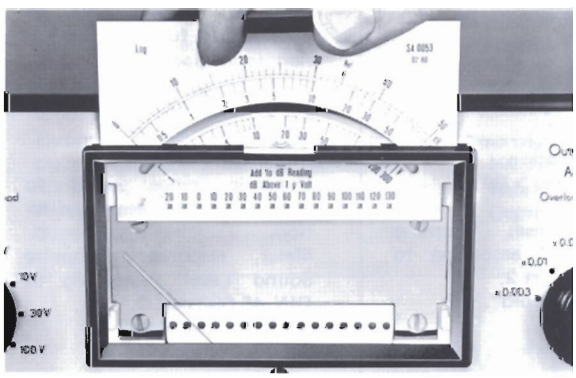
Power Requirement:
100, 115, 127, 150, 220, 240 V AC
± 10% 50, to 400 Hz.
2606: 30 W
2607: 33 W
2608: 25 W
Alternatively 12 V DC ± 10%
2606: 24 W
2607: 31 W
2608: not applicable.

Individual Specifications

Type Number	2608	2606	2607
Built-in Filters:	High pass 22.4 Hz. Slope > 18 dB/octave. Fixed low pass 315 kHz, slope approx. 18 dB/octave.	High pass 22.4 Hz. Low pass 22.4 kHz. Both filters have slope > 24 dB/octave and outside 5 Hz and 125 kHz more than 60 dB attenuation. Fixed low pass 315 kHz, slope approx. 18 dB/octave.	High pass 22.4 Hz. Low pass 22.4 kHz. Both filters have slope > 24 dB/octave and outside 5 Hz and 125 kHz more than 60 dB attenuation. Fixed low pass 315 kHz, slope approx. 18 dB/octave.

Type Number	2608	2606	2607
Weighting Networks:	A to IEC Recommendation 179.	A, B, C to IEC Recommendation 179, and D to proposed standard.	A, B, C to IEC Recommendation 179, and D to proposed standard.
Meter Indication:	RMS indication is within: ± 0.5 dB for crest factors < 5. Meter response FAST and SLOW according to IEC 179.	RMS indication is within: ± 0.5 dB for crest factors < 10. ± 1.0 dB for crest factors < 20. ± 2.0 dB for crest factors < 40. Crest factors < 40 at reduced meter deflection. Meter response FAST and SLOW according to IEC 179. Impulse indication is within: ± 0.5 dB for crest factor 5. Meter response: "Impulse Sound Level" according to DIN 45 633 part 2 Impulse HOLD better than 0.05 dB/sec.	RMS indication is within: ± 0.5 dB for crest factors < 5. Meter response FAST and SLOW according to IEC 179. Adjustable averaging times: 0.1, 0.3, 1, 3, 10, 30, 100, and 300 sec. Impulse indication is within: ± 0.5 dB for crest factor 5. Meter response: "Impulse Sound Level" according to DIN 45 633 part 2 Impulse HOLD better than 0.05 dB/sec. Peak indication: + peak, −peak, max. peak. Rise time 20 µsec. Hold time 400 msec. Decay times: 0.1, 0.3, 1, 3, 10, 30, 100 and 300 sec
Meter Reset:	None	Push Button Impulse decay time: < 70 msec	Push Button: RMS averaging time: 100 msec Impulse decay time: 100 msec Peak decay time: 100 msec Remote Control: RMS averaging time: 100 msec. Impulse decay time: < 70 msec Peak decay time: 10 msec
Output Signal:	AC: 10 V RMS at full scale deflection. AC: Max. 50 V Peak, into 16 kΩ//200 pF.	AC: 5 V RMS at full scale deflection. AC: Max. 50 V peak, into 16 kΩ//200 pF. DC: −0.9 V at full scale deflection. DC: Max. output −2.2 V. 1. RMS indication: Dynamic range: > 20 dB 2. Impulse indication: Dynamic range: > 20 dB Meter response: "Impulse Sound Level" according to DIN 45 633 part 2, and "Impulse Hold".	AC: 10 V RMS at full scale deflection. AC: Max 50 V peak, into 16 kΩ//200 pF. DC: + 4.5 V at full scale deflection. 1. RMS indication: Dynamic range: −50 to + 10 dB re. full scale deflection (crest factor up to 1.4). Averaging times: 0.1, 0.3, 1, 3, 10, 30, 100, 300 sec. Max. DC voltage: 15 V. 2. Impulse indication: Dynamic range: −36 to + 10 dB re full scale deflection. Meter response: "Impulse Sound Level" according to DIN 45 633 part 2, and "Impulse Hold". Max. DC voltage: 15 V. 3. Peak indication: Dynamic range: −36 to + 14 dB re full scale deflection. Rise time: 20 µsec. Hold 400 msec. Decay times: 0.1, 0.3, 1, 3, 10, 30, 100, 300 sec. An externally controlled decay time removes the 400 msec hold. Max. DC voltage: 25 V.

Type Number	2608	2606	2607
Output Impedance (Output Socket):	50 Ω (AC).	50 Ω (AC), 25 kΩ (DC).	50 Ω (AC), 820 Ω (DC).
AC Output Load Impedance:	> 16 kΩ//200 pF. (200 kHz).	> 16 kΩ//200 pF. (200 kHz).	> 16 kΩ//200 pF. (200 kHz)
Lin-Log Converter:			Dynamic range: 50 dB corresponding to scale deflection from zero to full scale. Linearity: ± 0.5 dB.
Reference Voltage (Built-in oscillator):	Mains frequency square wave, Zener diode stabilized. RMS stability better than ± 0.05 dB for ± 10% line voltage variation.	50 mV at 1000 Hz, sinusoidal. Amplitude stability better than ± 0.01 dB for ± 10% line voltage variation, and ± 0.005 dB/°C (app. ± 0.003 dB/°F).	50 mV at 1000 Hz, sinusoidal. Amplitude stability better than ± 0.01 dB for ± 10% line voltage variation, and ± 0.005 dB/°C (app. ± 0.003 dB/°F)
Weight (A cabinet):	6.0 kg (13.2 lb).	7.0 kg (15.5 lb).	7.6 kg (16.7 lb).
Accessories Included:	Power cable. AO 0013 Screened cable. Spare lamps & fuses	Power cable. AO 0013 Screened cable. JP 0703 7-pin DIN plug JP 0802 8-pin DIN plug Spare lamps & fuses.	Power cable. AO 0013 Screened cable. JP 0802 8-pin DIN plug JP 1501 15 pin plug. Spare lamps & fuses.
Meter Scales Included:	Voltage and dB scale non-interchangeable.	SA 0037: voltage and dB (mounted in the instrument on delivery) SA 0038: for dB and voltage SA 0039: for 1" microphone SA 0040: for 1/2" microphone SA 0071: for 6 to 17 mV/g accelerometer SA 0086: uncalibrated, linear graduation 0 to 100	SA 0051: voltage and dB (mounted in the instrument on delivery) SA 0052: for dB and voltage (Lin) SA 0053: for dB and voltage (Log 50 dB) SA 0056: for 1" microphone SA 0057: for 1/2" microphone SA 0058: for 6 to 17 mV/g accelerometer SA 0059: for dB Lin/Log (Log 50 dB. Lin 20 dB) SA 0087: uncalibrated, linear graduation 0 to 100
Extra Meter Scales Available: (Scales can also be custom made to order).	None.	SA 0028: Blank scale without markings SA 0045: for Absorption coefficient SA 0046: for Power Spectral Density SA 0061: for 1/4" microphone SA 0070: for 17 to 60 mV/g accelerometer SA 0073: for 1/8" microphone SA 0074: for 1.7 to 6 mV/g accelerometer SA 0075: for 60 to 170 mV/g accelerometer SA 0077: for dB/dBm SA 0091: for 1/2" microphone SA 0092: for 1/2" microphone SA 0158: for 32 to 100 mV/g accelerometer SA 0159: for 32 to 100 mV/g accelerometer	SA 0028: Blank scale without markings SA 0054: for Absorption Coefficient SA 0055: for Power Spectral Density SA 0060: for 1/4" microphone SA 0083: for 1/8" microphone SA 0084: for dB/dBm SA 0142: for 1.7 to 6 mV/g accelerometer SA 0143: for 17 to 60 mV/g accelerometer SA 0144: for 60 to 170 mV/g accelerometer



2. CONTROLS

2.1. FRONT PANEL

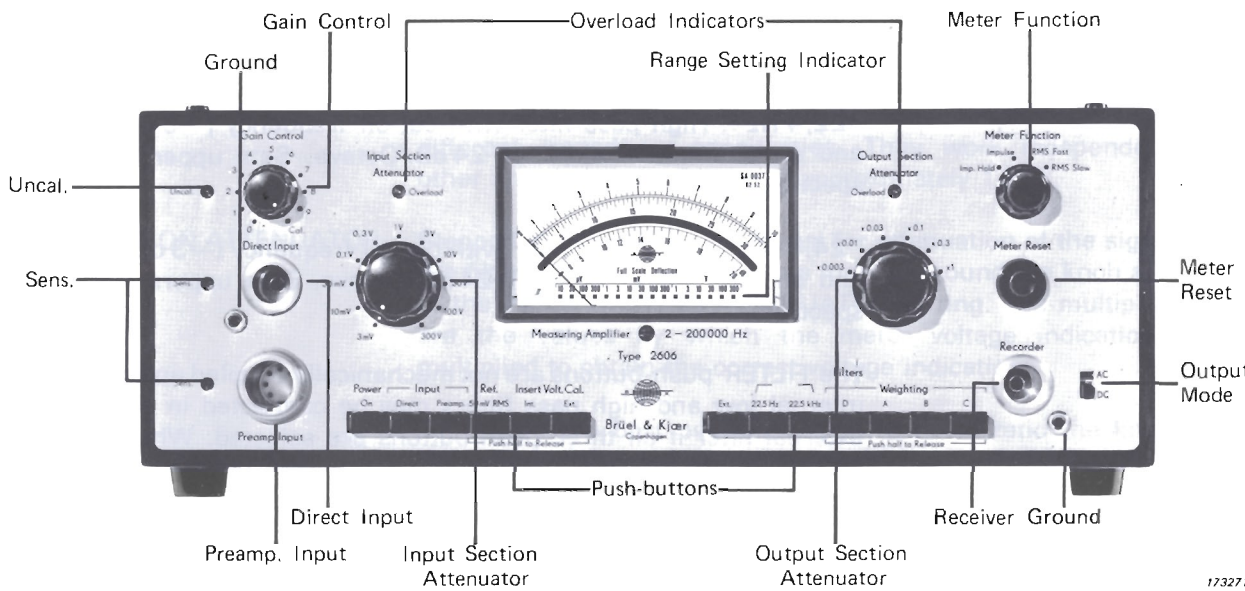


Fig. 2.1. Front Panel of the 2606

METER: A moving coil indicating meter with mirrored back to avoid parallax errors. At the bottom of the meter, neon indicators automatically indicate the measurement range selected using the INPUT AND OUTPUT SECTION ATTENUATORS of the instrument. For measurement of sound, vibration and voltage separate interchangeable scales are provided. To replace a meter scale the meter may be released by pushing down and pulling forward the central clip on top of the meter. The meter should then tilt slightly forward enabling the scale to be slid out and a new scale inserted.

Immediately below the meter are two rows of push-buttons. Their functions are as follows:

POWER: On/Off push-button for power. When set to "On" (i.e. inner position) and an AC mains supply is connected to the MAINS INPUT socket, at the rear of the instrument, the meter scale lamps should light.

INPUT: "Direct" input, or input via "Preamplifier" may be chosen by depressing the appropriate push-button.

REF.: Is used for calibration of the 2606. It connects a stabilized 50 mV, 1 kHz sine wave signal to the "Direct" or "Preamplifier" input selected with the INPUT push-buttons.

INSERT VOLT. CAL.: Choice of internal or external signal for insert voltage calibration of measurement transducers, as described in section 3.8. "Int." selects the internal 50 mV, 1 kHz reference signal, whilst "Ext." selects the output of an external signal generator, which may be connected to the INSERT VOLT. CAL. socket at the rear of the instrument.

FILTERS: Three push-buttons with the following functions:
"Ext.". Choice of internal or external filters or weightings. When this push-button is set in outer position the internal filters or weightings selected with the other push-buttons are connected. When set in inner position an external filter, which may be connected to the EXT. FILTER INPUT AND OUTPUT sockets on the rear of the instrument, is selected.

"22,4 Hz". High pass filter with cut-off frequency (—3 dB) at 22,4 Hz and an attenuation slope of 24 dB/Octave. Sets upper end of audio spectrum.

"24,4 kHz". Low pass filter with cut-off frequency (—3 dB) at 24,4 kHz and an attenuation slope of 24 dB/Octave. Sets uppers end of audio spectrum.

The FILTER push-buttons are not mechanically coupled and therefore the internal low and high pass filters may be connected in series with an external filter if all three push-buttons are selected. When neither the FILTER or WEIGHTING push-buttons are selected, the 2606 has a response of 2 Hz to 200 kHz which is linear within ± 0,5 dB limits.

WEIGHTING: Four push-buttons, for selection of A, B, C and D weighting networks for sound measurements. The push-buttons are mechanically coupled and therefore only one weighting network may be selected at one time.

The remaining controls and sockets on the front panel are:

GAIN CONTROL: For continuous control of the gain of the instrument's input amplifier. When in position "Cal." (Click-stop position) the gain of the amplifier is fixed. The maximum attenuation from the "Cal." position is approximately 10 dB. The control operates with either DIRECT or PREAMP. input selected.

UNCAL.: This light operates when the GAIN CONTROL knob is in an uncalibrated position.

INPUT SECTION ATTENUATOR: For attenuation of input signal by 10 dB steps. Voltages marked around the knob show the maximum input voltage (for full scale deflection) for each knob setting. By using the Gain Control input voltages up to 700 V peak can be measured. See section 3.6.2.

OVERLOAD INDICATORS: These indicate overload in input or output amplifiers. While the lights flash the meter reading is inaccurate and less than the correct value.

DIRECT INPUT: Coaxial socket input to the input amplifier. Input impedance 1 MΩ//50 pF. Takes B & K plugs JP 0101.

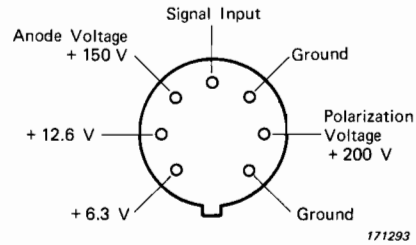


Fig.2.2. PREAMP. INPUT (viewed from rear of connection plug or outside of socket)

PREAMP. INPUT: 7 pin socket for connection of B & K microphones via their preamplifier. The input impedance is 900 kΩ//50 pF. For connections see Fig.2.2.

SENS.: Two screwdriver operated potentiometers situated by their respective inputs. They adjust the gain of the input amplifier to compensate for different transducer sensitivities. They work independently of each other and each has a range of approximately 14 dB.

OUTPUT SECTION ATTENUATOR: Stepped attenuator (10 dB steps) for attenuation of the signal level after the filter section. The dB values marked around the knob are dB relative to the INPUT SECTION ATTENUATOR setting. The multiples (x) marked are the values by which the meter voltage indication has to be multiplied to obtain the correct voltage indication.

To ensure the best possible signal to noise ratio the knob should be kept as far clockwise as possible.

METER FUNCTION: Five position switch for the selection of the following meter characteristics:

"RMS Fast" and "RMS Slow". In these positions the meter indicates true RMS levels for signals with crest factors up to 10 for full scale deflection on the meter (up to 40 for lesser deflections). Fast and Slow refers to the damping characteristics of the meter circuit.

"Impulse". The meter indicates impulse sound levels. Is used to give a subjective impression of short duration sounds.

"Impulse Hold" In this position the meter will indicate and hold the maximum impulse sound level of the applied signal. At 25°C the impulse level held will decay at less than 0,05 dB/s.

"Peak Hold". The meter will indicate and hold the maximum peak level (positive or negative depending on which is greatest) of the applied signal. At 25°C the peak level will decay at less than 0,05 dB/s.

METER RESET: Resets the meter indication when impulse or peak hold measurements are made.

RECORDER: Output for AC or DC recording. For AC recording the output is derived from the Output Section Amplifier of the instrument which has an output impedance of approximately 50 Ω, but should not be loaded by less than 16 kΩ. The maximum open circuit output voltage available for AC recording is $50\,V_{pk}$, whilst the open circuit output voltage

corresponding to full scale deflection on the meter is 5 V_{RMS}. For DC recording the output is derived from the Meter Circuit of the instrument which has an output impedance of 25 kΩ and produces a maximum open circuit output voltage of 1,35 V. The open circuit DC output voltage corresponding to full scale deflection on the meter is 900 mV.

The RECORDER socket accepts the B & K coaxial plug JP 0101.

OUTPUT MODE: For selection of an AC or DC output from the RECORDER socket.

2.2. REAR PANEL

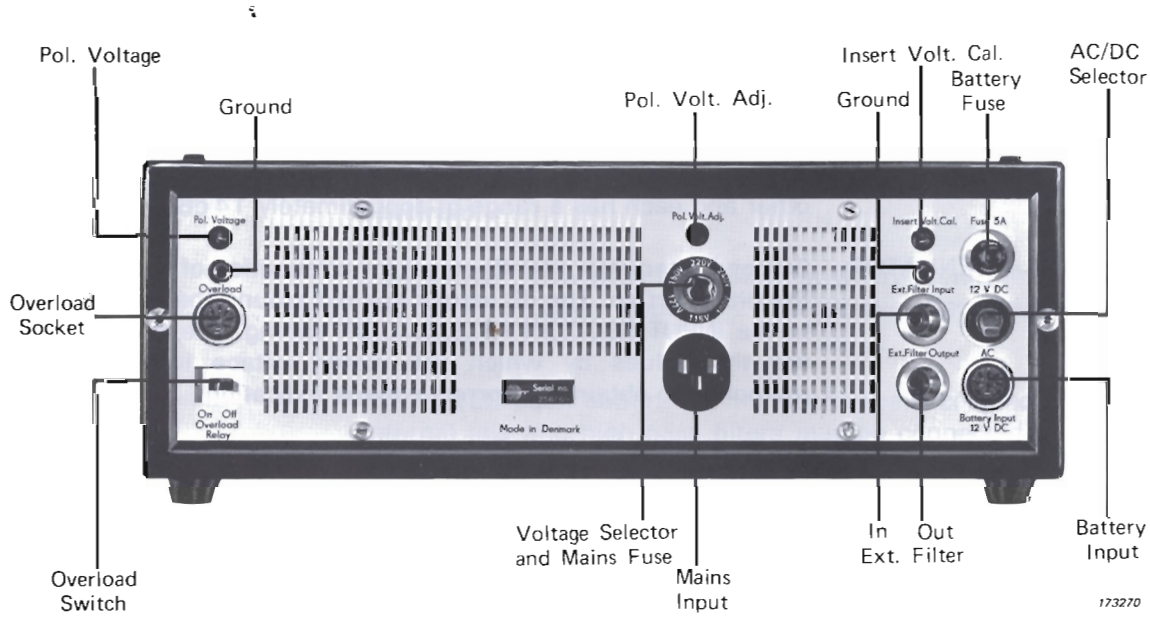


Fig. 2.3. Rear Panel of 2606

AC/DC SELECTOR: For selection of mains or battery operation of the 2606.

MAINS VOLTAGE SELECTOR AND MAINS FUSE: Voltage selector for selection of the correct mains voltage. The selector also contains a 250 mA mains fuse.

To remove the fuse, press in the central knob, containing the fuse, and turn it counter-clockwise. Half a turn should be sufficient to release the knob, which may then be pulled straight out.

Behind the knob are some slots which with the aid of a coin may be used to turn the selector so that the white line points to the correct voltage indication.

Note. Verify the mains voltage selection before each use of the 2606.

MAINS INPUT: Input socket accepting the power cable AN 0010 provided for connection of a mains supply. With the ground pin of the socket (see Fig. 2.4) connected to the earth of the mains supply either chassis or signal ground may be selected as shown in section 3.1.3.

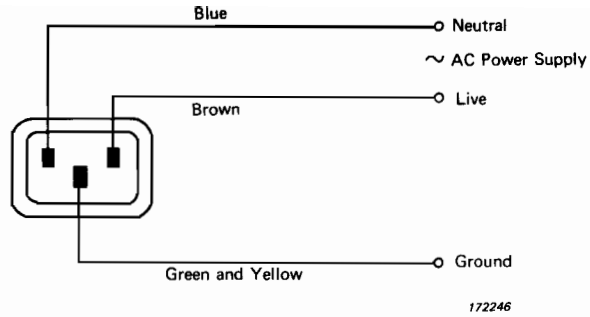


Fig.2.4. MAINS INPUT connection (viewed from outside of socket)

BATTERY FUSE: 5 amp. protection fuse for operation of the 2606 from an external 12 volt battery supply which may be connected to the BATTERY INPUT socket.

BATTERY INPUT: 8 pin socket accepting the DIN plug (B & K no. JP 0802) provided for connection of a 12 volt battery supply to power the 2606. The maximum current consumption is 2 amps. For connections see Fig.2.5.

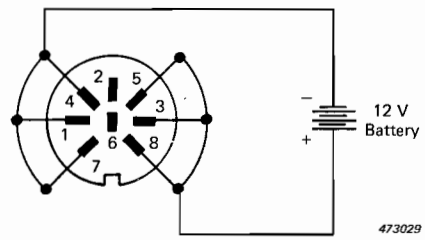


Fig.2.5. Connection of an external 12 volt battery supply to the BATTERY INPUT socket of the 2606

POL. VOLT. ADJ.: Screwdriver adjustable potentiometer for adjustment of the 200 V DC polarization voltage.

Note: This control is factory preset and does not normally require adjustment. However, if adjustment is required then the procedure given in section 3.1.2. should be followed.

POL. VOLTAGE: Socket for measurement of polarization voltage using a digital voltmeter having a rating of at least 20 kΩ/volt. A ground socket is situated to the right of this socket.

Note: Only signal ground should be used when checking the polarization voltage. To select signal ground see section 3.1.3.

OVERLOAD SOCKET: 7 pin DIN socket accepting the DIN plug (B & K no. JP 0703) provided, for connecting the overload relay of the 2606 to a 2305 or 2307 Level Recorder. On overload the relay will stop the paper drive of Recorder or give a recorded indication that overload has occurred. For further information and connections see section 3.9.

OVERLOAD SWITCH: On/Off switch for the internal connection or disconnection of the overload realy to the OVERLOAD SOCKET.

INSERT VOLT. CAL.:

Input socket for application of an external signal for insert voltage calibration of condensor microphones (see section 3.8). The input impedance is 1 kΩ. A ground return socket is situated immediately below the INSERT VOLT. CAL. socket.

EXT. FILTER INPUT/OUTPUT:

These sockets are for connection to an external filter and accept the B & K coaxial plugs JP 0101. The input impedance of the EXTERNAL FILTER OUTPUT is 146 kΩ//100 pF, while the output impedance of the EXTERNAL FILTER INPUT is low (< 10Ω), but must not be loaded by less than 500 Ω. Maximum output voltage is 5,6 V peak.

3. OPERATION

3.1. ADJUSTMENTS

3.1.1. Preliminary Adjustments

Before the instrument is used, the following adjustments should be made.

1. With POWER off and any meter scale fitted, set the pointer deflection on the meter to zero, using the mechanical adjuster immediately below the meter.

2. Set the AC/DC SELECTOR switch on the rear panel to "AC" for mains operation or to DC for operation from a battery supply.

   If a mains supply is to be used check that the VOLTAGE SELECTOR is set to the correct mains voltage. If not unscrew the knob at the centre of the selector and turn the selector to the correct voltage indication using a small coin, or wide blade screw driver.

   Once the VOLTAGE SELECTOR has been set to the correct mains voltage the mains supply may be connected to the MAINS INPUT socket using the power cable AN 0010, provided. To fit a suitable mains plug to the cable see Fig.2.4.

   If a battery supply is used then it should have a voltage rating of 12 volts and should deliver approximately 2 amps. The necessary battery connections are given in Fig.2.5. It should be noted that with battery operation the meter scale lamps are not lit, saving approximately 6 watts. However, the range indicator lights of the meter will function and will show when the instrument is on.

   The above adjustments are part of the normal operating procedure. However, occasionally it may also be found necessary to adjust the instrument's microphone polarization voltage and to set the signal reference.

3.1.2. Polarization Voltage

The 200 V DC polarization voltage is factory preset to within ± 1 V and therefore further adjustment is not normally necessary. However, if at some time it is required to check or adjust the polarization voltage then this should be measured by connecting a digital voltmeter (meter rating 20 kΩ/volt) to the POL. VOLTAGE socket. Adjustment may be carried out using the POL. VOLT. ADJ. potentiometer at the rear of the instrument.

It should be noted that only signal ground should be used when making this adjustment (see section 3.1.3).

3.1.3. Signal or Chassis Ground

As with most mains operated instruments the 2606 has a small capacitance path to ground which can result in noise pick-up. To prevent this influencing the accuracy of measurements the 2606 together with other mains operated instruments with which it is used must be adequately grounded. Usually this is best carried out by connecting the chassis of the individual instruments to the earth of the mains supply and then interconnecting their signal ground lines using screened cable to couple their input and output sockets. Grounding of the signal ground lines should then be made by connecting the signal ground line of one of the instruments to chassis. To prevent ground loops from being formed it is important to ensure that only one signal ground point is used in the measuring arrangement and therefore the chassis of the other instruments in the arrangement should be isolated from the signal ground lines.

So as to suit the above grounding requirements either just the chassis of the 2606 or its signal ground line together with its chassis may be grounded. Chassis ground is obtained by connecting the earth pin of the MAINS INPUT socket to the earth of the mains supply as shown in Fig.2.4. Signal ground (i.e. signal ground line connected to the earth of the mains supply via chassis) is then obtained by connecting the small screw held plate on the underside of the main printed circuit board of the apparatus, to the "Signal Gnd" and "Chassis" terminals shown in Fig.3.1. To isolate the signal ground line from the chassis, as will be required when the chassis of another instrument is used to obtain signal ground, the "Chassis" terminal and the unmarked terminal immediately beneath it should be connected using the plate.

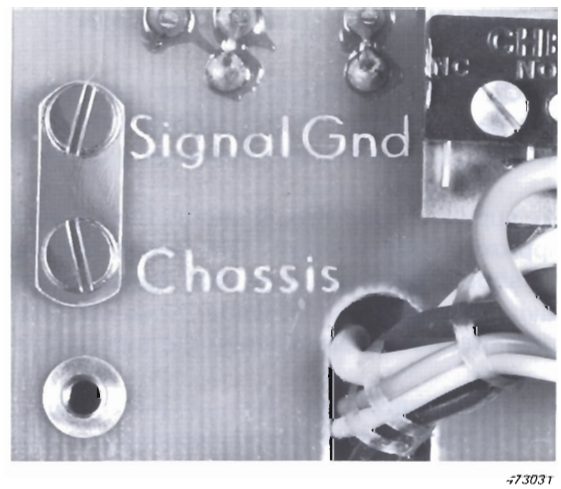


Fig.3.1. The Chassis Switch of the 2606

3.2. CALIBRATION FOR SOUND MEASUREMENTS

For sound level measurements, the 2606 may be calibrated using the internal reference voltage provided. However, if more precise calibration is required then a Pistonphone 4220 or Sound Level Calibrator 4230 should be used. The Pistonphone may be directly coupled to any one of the condenser microphones in the B & K range and produces a

nominal sound pressure level of 124 dB re 20 μPa* at 250 Hz. It has an accuracy of ± 0,2 dB. The Sound Level Calibrator fits one-inch and half-inch B & K condenser microphones and produces a nominal sound pressure level of 94 dB re 20 μPa* at 1 kHz. Its calibration accuracy is ± 0,25 dB.

3.2.1. Using the Pistonphone or Sound Level Calibrator

To calibrate the 2606 using the Pistonphone or Sound Level Calibrator proceed as follows:

1. Carry out the preliminary adjustments necessary.

2. Fit the meter scale appropriate to the sensitivity of the microphone to be used. See Table 3.1.

Microphone Open Circuit Sensitivity	Microphone B&K Type	Scale No.
26 to 80 mV/pascal	4144 4145 4146 4161	SA 0039
5 to 30 mV/pascal	4133 4134 4147	SA 0040
9 to 26 mV/pascal	4149 4163	SA 0091
2,6 to 9 mV/pascal	4135	SA 0092
0,8 to 2,6 mV/pascal	4136 4138	SA 0061
0,28 to 1,6 mV/pascal	4138	SA 0073

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Table 3.1. Microphone scales for use with 2606

3. Fit the microphone and associated preamplifier to the appropriate input socket on the 2606.

4. Set the controls on the 2606 as follows:

INPUT	as appropriate
GAIN CONTROL	"Cal."
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS Fast"
FILTERS	Linear 22,4 Hz to 200 kHz "Ext." push-button out with "22,4 Hz" push-button set in
POWER	"On"

Allow 30 seconds for the 2606 to warm up.

5. Set the INPUT SECTION ATTENUATOR so that 120 dB (for Pistonphone calibration) or 90 dB (for Sound Level Calibrator calibration) is indicated as the zero level on the meter scale by the range indicator lamps of the meter.

* For the exact sound pressure, the Pistonphone or Sound Level Calibrator calibration chart should be consulted. 1 pascal corresponds to a sound pressure of 1 N/m^2.

6. Using the Pistonphone 4220 or Sound Level Calibrator 4230, the meter should read* 124 or 94 dB respectively. If it does not, adjust the SENS. potentiometer beside the INPUT socket being used until the correct meter indication is obtained.

3.2.2. Using Internal Reference Voltage

1. Carry out the preliminary adjustments necessary.

2. Fit the meter scale appropriate to the sensitivity of the microphone to be used. See Table 3.1.

3. Fit the microphone and associated preamplifier to the appropriate input of the 2606. Any microphone accessories can remain in position.

4. Set the controls on the 2606 as follows:

INPUT	as required
GAIN CONTROL	"Cal."
INPUT SECTION ATTENUATOR	"0,1 V"
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS Fast"
REF.	"50 mV RMS"
FILTERS	Lin. 2 Hz to 200 kHz "Ext.", "22,4 Hz" and "22,4 kHz" push-buttons set in out position
POWER	"On"

Allow 30 seconds for the 2606 to warm up.

5. Determine the sensitivity S_{MP} of the microphone and preamplifier combination employed. This can be calculated from:

$$S_{MP} = S_{OC} + g + 20 \log_{10} \frac{C_M}{C_p + C_m} \quad \text{dB re 1 V per Pa}$$

where S_{OC} is the open circuit sensitivity of the microphone (dB re 1 V per Pa), C_M is the microphone cartridge capacitance, g is the gain of the preamplifier (dB) and C_p is the input capacitance of the preamplifier. Values for S_{OC} and C_M can be obtained from the calibration chart of the microphone employed, whilst those for g and C_p are given in the Specifications Chapter of the relevant instruction manual.

Example:
Suppose a half-inch Microphone Type 4134 with an open circuit sensitivity of —59,3 dB re 1 V per Pa and a capacitance of 20 pF is used with a Microphone Preamplifier Type 2619, which has a gain of 0,03 dB and an input capacitance of 0,8 pF.

Then: $S_{MP} = -59{,}3 - 0{,}03 + 20 \log \frac{20}{20{,}8}$

$= -59{,}3 \quad -0{,}03 \quad -0{,}342$

$S_{MP} = -59{,}7$ dB re 1 V per Pa

* For the exact sound pressure, the Pistonphone or Sound Level Calibrator calibration chart should be consulted.

6. Using a small screwdriver adjust the SENS. potentiometer beside the input socket that is being used, until the required sensitivity is indicated on the "Micr. Sens." range of the meter scale.

7. Having calibrated the arrangement, press the "50 mV RMS" push-button to release it, disconnecting the reference voltage.

3.3. MEASUREMENT OF SOUND

1. Calibrate the 2606 for sound by one of the methods described in section 3.2.

2. Hold the microphone steadily at least 1 m away from the body or set it up on a tripod or other support that will not interfere with the sound field.

3. Using the FILTER and WEIGHTING push-buttons select the appropriate linear mode or weighting network to be used for measurements. If external filters are to be used then they may be connected to the EXT. FILTER INPUT AND OUTPUT sockets of the 2606 after the "Ext." FILTER push-button has been set to its inner position.

4. Keeping the OUTPUT SECTION ATTENUATOR in its "x 1" position adjust the INPUT SECTION ATTENUATOR to obtain a suitable deflection on the meter without the INPUT OVERLOAD INDICATOR lamp lighting. If the deflection is insufficient even when the INPUT SECTION ATTENUATOR is in its "3 mV" position, then adjust the OUTPUT SECTION ATTENUATOR until a suitable deflection is obtained without the OUTPUT OVERLOAD INDICATOR lamp lighting.

5. The measured sound level or sound pressure level is given by the meter reading (dB) + dB value indicated by the meter's range indicator lamps.

   In reporting sound levels it should always be stated which weighting network has been used, e.g. 60 dB (A), 60 dB (D) or for impulse measurements 60 dB (A1).

   The maximum SPLs that can be measured accurately with one-inch and half-inch microphones with respect to the crest factor of the signal can be seen in Fig. 3.2.

For further information on sound measurements the booklet "Acoustic Noise Measurements" is available on request.

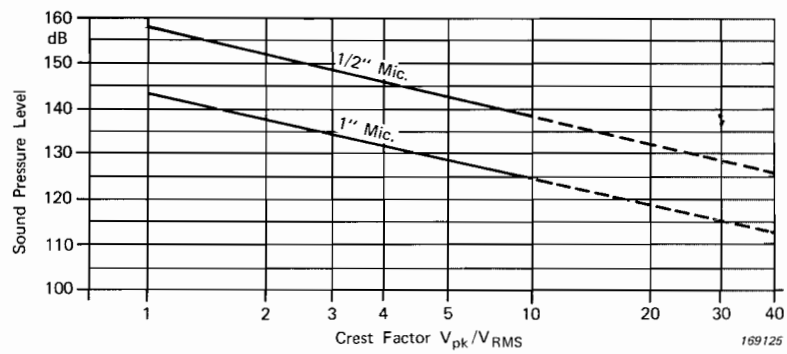

Fig. 3.2. Maximum sound pressure levels of half-inch and one-inch condenser microphones

3.4. CALIBRATION FOR VIBRATION MEASUREMENTS

For vibration measurements the 2606 together with a preamplifier, accelerometer combination may be calibrated using the internal reference voltage provided. However, a more precise calibration can be obtained using either the Vibration Calibrator 4291 or the Accelerometer Calibrator Preamplifier 4292. Both instruments contain built-in shaker tables which have a 10— 32 NF threaded hole for mounting accelerometers. The tables vibrate at a frequency of 79,6 Hz (79,6 Hz corresponds to ω = 500 rad/sec) as specified by the DIN Recommendation 45666 and produce a vibration acceleration level of 1 g peak (9,81 m/s^2). An important feature of 4292 is that it also contains a voltage preamplifier to couple the output from the accelerometer to the input of the 2606. With the 4291 a separate voltage or charge preamplifier (see Fig.5.2) must be used. The calibration accuracy of the 4291 and the 4292 is better than ± 2% and ± 10% respectively.

3.4.1. Using the Vibration and Accelerometer Calibrators

To calibrate proceed as follows:

1. Carry out the preliminary adjustments necessary.

2. Fit the meter scale appropriate to the sensitivity of the accelerometer to be used. See Table 3.2.

3. Fit the accelerometer and associated charge or voltage preamplifier to the appropriate input socket of the 2606.

4. Set the controls on the 2606 as follows:

INPUT	as appropriate
GAIN CONTROL	"Cal."
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS Fast"
FILTERS	Lin. 2 Hz to 200 kHz "Ext.", 22,4 Hz" and "22,4 kHz" push-buttons set in out position
POWER	"On"

Allow 30 seconds for the 2606 to warm up.

Accelerometer Sensitivity	Accelerometer B&K Type	Scale No.
60 to 170 mV/g	4338	SA 0075
17 to 60 mV/g	4332 4334	SA 0070
6 to 17 mV/g	4333 4335 4339 4340 4343 8031 8302	SA 0071
1,7 to 6 mV/g	4344 8303	SA 0074

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Table 3.2. Accelerometer scales for use with 2606

5. Set the INPUT SECTION ATTENUATOR so that a full scale deflection of 1 g is indicated by the range indicator lamps of the meter.

6. Select the "Acceleration" mode of the preamplifier.

7. Using the shaker table of the Vibration Calibrator 4291 or of the Accelerometer Calibrator Preamplifier 4292 vibrate the accelerometer at 1 g peak.

8. Using the SENS. potentiometer beside the input used on the 2113, or the sensitivity control of the preamplifier, adjust the meter indication of the 2606 to read an acceleration level of 0,707 g RMS (i.e. 0,707 g RMS = 1 g peak).

3.4.2. Using Internal Reference Voltage

To calibrate proceed as follows:

1. Carry out the preliminary adjustments necessary.

2. Fit the meter scale appropriate to the sensitivity of the accelerometer to be used. See Table 3.2.

3. Fit the accelerometer and associated charge or voltage preamplifier to the appropriate input socket of the 2606.

4. Select the "Acceleration" mode of the preamplifier.

5. From the calibration chart of the accelerometer, calculate what acceleration level corresponds to a voltage output from the preamplifier of 50 mV RMS. For example if a B & K Type accelerometer of sensitivity 10,1 pC/g is used with a Type 2651 Charge Amplifier on a gain setting of 1 mV/pC, a voltage level of 50 mV RMS is produced by a signal of 4,95 g RMS.

6. Set the controls on the 2606 as follows:

INPUT	as appropriate
GAIN CONTROL	"Cal."
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS Fast"
FILTERS	Lin. 2 Hz to 200 kHz "Ext.", "22,4 Hz" and "22,4 kHz" push-buttons set in out position
POWER	"On"

Allows 30 seconds for the 2606 to warm up.

7. Set the INPUT SECTION ATTENUATOR so that the acceleration level calculated in item 5 will appear on scale. For the example given, the INPUT SECTION ATTENUATOR should be set so that the meter's range indicator lamps indicate an acceleration level of 10 g for full scale deflection on the meter.

8. Select the "50 mV RMS" push-button and adjust the SENS. Potentiometer beside the input socket in use so that the acceleration level calculated in item 5 is correctly indicated on the meter.

9. Having calibrated the arrangement, press the "50 mV" push-button to release it, disconnecting the reference voltage.

3.5. MEASUREMENT OF VIBRATION

1. Calibrate the 2606 for vibration by one of the methods described in section 3.4.

2. Mount the accelerometer as rigidly as possible onto the measurement object, taking care to avoid cable whip.

3. Keep the 2606 as far away as possible from the vibration environment and any other unrequired influences.

4. Using the FILTER push-button select the appropriate linear mode for measurements. Do not select any weighting networks as these are for sound measurements only. If external filters are to be used then these may be connected to the EXT. FILTER INPUT AND OUTPUT sockets of the 2606 after the "Ext" FILTER push-button has been set to its inner position.

5. Keeping the OUTPUT SECTION ATTENUATOR in its "x 1" position adjust the INPUT SECTION ATTENUATOR to obtain a suitable deflection on the meter without the INPUT OVERLOAD INDICATOR lamp lighting. If the deflection is insufficient even when the INPUT SECTION ATTENUATOR is in its "3 mV" position, then adjust the OUTPUT SECTION ATTENUATOR until a suitable deflection is obtained without the OUTPUT OVERLOAD INDICATOR lamp lighting.

6. The acceleration level of the measured vibration can be obtained directly from the meter deflection where the acceleration level in g for full scale deflection is given by the meter's range indicator lamps.

For further information on vibration measurements the booklet "Mechanical Vibrations and Shock Measurements" is available on request.

3.6. CALIBRATION FOR VOLTAGE MEASUREMENTS

3.6.1. Input Voltages up to 300 V RMS

1. Carry out the preliminary adjustments necessary.

2. Fit the Voltage scale SA 0037 or SA 0038.

3. Set the controls on the 2606 as follows:

INPUT	as required
GAIN CONTROL	"Cal."
INPUT SECTION ATTENUATOR	"0,1 V"
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS Fast"
REF.	"50 mV RMS"
FILTERS	Lin. 2 Hz to 200 kHz "Ext.", "22,4 Hz" and "22,4 kHz" push-buttons set in out position
POWER	"On"

Allow 30 seconds for the 2606 to warm up.

4. Using the SENS. potentiometer control beside the appropriate INPUT socket, adjust the meter pointer to the 50 mV reference mark on the meter scale.

5. After calibration press the "50 mV RMS" REF. push-button to release it, disconnecting the reference voltage.

3.6.2. Input Voltages up to 700 V peak

Use can be made of the GAIN CONTROL to accommodate input voltages up to 700 V_{pk}, which is the maximum peak input voltage rating of the 2606 when the 0,3 V to 300 V range settings of its INPUT SECTION ATTENUATOR are employed. For INPUT SECTION ATTENUATOR range settings of 3 mV to 0,1 V the maximum peak input voltage rating is 310 V_{pk} for signal frequencies less than 60 Hz, 165 V_{pk} for signal frequencies less than 400 Hz and 20 V_{pk} for signal frequencies above 400 Hz. Under no circumstances should these maximum ratings be exceeded, as otherwise the instrument will be damaged.

To calibrate for voltage measurements up to 700 V peak proceed as follows:

1. Carry out items 1 to 5 of section 3.6.1.

2. With the meter pointer set on the 50 mV reference mark set the INPUT SECTION ATTENUATOR to "30 mV", causing the pointer to deflect off scale.

3. Adjust the GAIN CONTROL to bring the pointer back to the red reference mark.

4. After calibration, press the "50 mV RMS" REF. push-button to release it, disconnecting the reference voltage.

3.7. VOLTAGE MEASUREMENTS

1. Calibrate the 2606 for voltage measurements by one of the methods described in section 3.6.

2. Set the INPUT SECTION ATTENUATOR at a suitably high voltage setting.

3. Using the FILTER push-button select the appropriate linear mode for measurements. Do not select any weighting networks as these are intended for sound measurements only. If external filters are to be used then these may be connected to the EXT. FILTER INPUT AND OUTPUT sockets of the 2606 after the "Ext" FILTER push-button has been set to its inner position.

4. Apply the voltage to be measured to the appropriate input socket.

5. Keeping the OUTPUT SECTION ATTENUATOR in its "x 1" position adjust the INPUT SECTION ATTENUATOR to obtain a suitable deflection on the meter without the INPUT OVERLOAD INDICATOR lamp lighting. If the deflection is insufficient even when the INPUT SECTION ATTENUATOR is in its "3 mV" position, then adjust the OUTPUT SECTION ATTENUATOR until a suitable deflection is obtained without the OUTPUT OVERLOAD INDICATOR lamp lighting.

6. For voltages up to 300 V RMS, when the calibration procedure given in section 3.6.1 has been applied, the measured voltage level can be obtained directly from the meter scale, where the voltage level for full scale deflection is indicated by the meter's range indicator lamps.

   For voltages up to 700 V_{pk}, when the calibration given in section 3.6.2 has been applied, the measured voltage level is obtained by multiplying the meter indication by 3,162.

3.8. INSERT VOLTAGE CALIBRATION

When a Preamplifier Type 2627 is used with the 2606, calibration of the open circuit sensitivity of one-inch condenser microphones may be made by applying the insert voltage method to determine a microphone's open circuit voltage. The advantage of this method is that the output of the microphone need not be open circuit, but can be terminated by a finite impedance, such as the input impedance of a preamplifier. The principle of the method can be explained with reference to Fig.3.3.

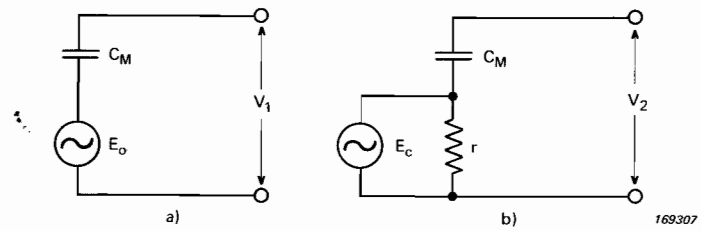

Fig.3.3 Insert voltage calibration of a condenser microphone

For calibration the microphone is first subjected to a sound pressure of known level and frequency. This causes the microphone to generate an internal voltage E_o (corresponding exactly to the open circuit microphone voltage) which when loaded by the input of a microphone preamplifier produces a loaded output voltage V_1 at the preamplifier output as in Fig.3.3(a). The sound pressure source is then removed and the internal voltage E_o substituted by an insert voltage E_c, which is applied in series with the microphone as shown in Fig.3.3(b). The insert voltage is adjusted so that the voltage V_2 at the preamplifier output equals V_1. When this occurs $E_c = E_o$ and therefore the open circuit sensitivity of the microphone can be calculated using the relation:

$$S_{oc} = \frac{E_c}{p} \text{ mV/Pa}$$

where S_{oc} is the microphone's open circuit sensitivity in mV/Pa
E_c is the insert voltage in mV used to generate V_2
and p is the sound pressure level in pascals used to generate V_1.

For insert voltage calibration using the 2627 with the 2606, the insert voltage can be supplied from either the internal 50 mV, 1 kHz reference source or from an external Beat Frequency Oscillator such as the B & K Types 1022 or 1024. If the internal reference source is used then a Sound Level Calibrator should be used as the sound source. This has a frequency of 1 kHz and generates a nominal sound pressure of 1 Pa (94 dB re 20 μPa) and therefore once E_c has been measured almost no calculation is involved in determining the open circuit sensitivity.

If the insert voltage is provided from an external source, either the Sound Level Calibrator or the Pistonphone 4220 may be used. The Pistonphone has a frequency of 250 Hz and generates a nominal sound pressure* of 31,6 Pa (124 dB re 20 μPa).

3.8.1. Using the Internal Reference Voltage

1. Calibrate the 2606 for voltage measurements using the PREAMP. input as described in section 3.6.1.

* For the exact sound pressure, the Pistonphone or Sound Level Calibrator calibration chart should be consulted.

2. Fit the microphone to be calibrated to the 2627 Preamplifier and connect the output of the preamplifier to the PREAMP. input of the 2606.

3. Apply the Sound Level Calibrator Type 4230 to the microphone and note the preamplifier's output voltage which is indicated by the meter of the 2606.

4. With the Sound Level Calibrator still coupled to the microphone, but no longer generating a reference SPL, depress the "Int. Insert Volt. Cal." push-button and adjust the gain control until the meter gives the same indication as obtained in item 3. The level of the insert voltage E_c will now be equivalent to the open circuit voltage E_o of the microphone.

5. Select the "50 mV RMS" REF. push-button and without readjusting the GAIN CONTROL note the level of the insert voltage E_c indicated on the meter of the 2606. The open circuit sensitivity S_{oc} of the microphone can then be calculated using:

$$S_{oc} = \frac{E_c}{p} \text{ mV/Pa}$$

where p is the sound pressure produced by the Sound Level Calibrator used. For the exact sound pressure consult the calibration chart provided with the calibrator.

3.8.2. Using an External Generator

1. Calibrate the 2606 for voltage measurements using both DIRECT and PREAMP. inputs as described in section 3.6.1.

2. Fit the microphone to be calibrated to the 2627 Preamplifier and connect the output of the Preamplifier to the PREAMP. input of the 2606.

3. Using the Pistonphone 4220 or the Sound Level Calibrator 4230, apply a reference sound pressure to the microphone and note the voltage indicated on the meter of the 2606.

4. Connect a signal generator to the INSERT VOLT. CAL. socket on the 2606 and adjust its frequency to the frequency of the sound pressure source. For the Pistonphone the frequency is 250 Hz, whilst for the Sound Level Calibrator it is 1 kHz.

5. With the sound pressure source still coupled to the microphone, but no longer generating a reference SPL, depress the "Ext. Insert Volt. Cal." push-button and adjust the output level of the generator until the same meter indication as obtained in item 3 is obtained. The level of the insert voltage E_c will now equal the open circuit voltage E_o of the microphone.

6. With the generator still connected to the INSERT VOLT. CAL. socket select the "Direct" INPUT push-button and using a lead connect the DIRECT input socket to the INSERT VOLT. CAL. socket. The meter of the 2606 will now indicate the insert voltage E_c provided by the generator.

   The open circuit sensitivity S_{oc} of the microphone can now be calculated using the relation:

$$S_{oc} = \frac{E_c}{p} \text{ mV/Pa}$$

where p is the sound pressure produced by the Pistonphone or Sound Level Calibrator used. For the exact sound pressure consult the calibration chart provided with the Pistonphone or Sound Level Calibrator.

3.9. USE OF OVERLOAD SOCKET

A schematic of the OVERLOAD SOCKET showing the identities of its external pin connections is given in Fig.3.4. The socket accepts the 7 pin DIN plug (B & K Type JP 0703) provided.

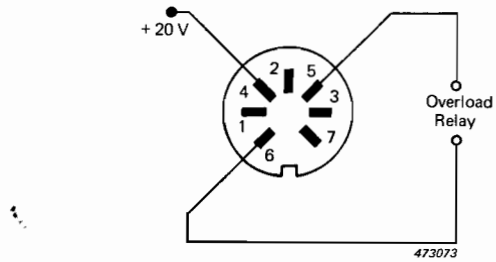

Fig.3.4. OVERLOAD socket of the 2606

3.9.1. Remote Overload Warning

When a 2305 or 2307 Level Recorder is used with the 2606, the control lines of the OVERLOAD socket may be used to operate the Recorder's pen lift, event marker or automatic stop, thus providing a remote warning that the amplifiers of the 2606 have been overloaded. To operate one of these Recorder facilities, set the OVERLOAD SWITCH of the 2606 to "On" and connect the OVERLOAD SOCKET to the REMOTE CONTROL socket of the Recorder as shown i Fig.3.5.

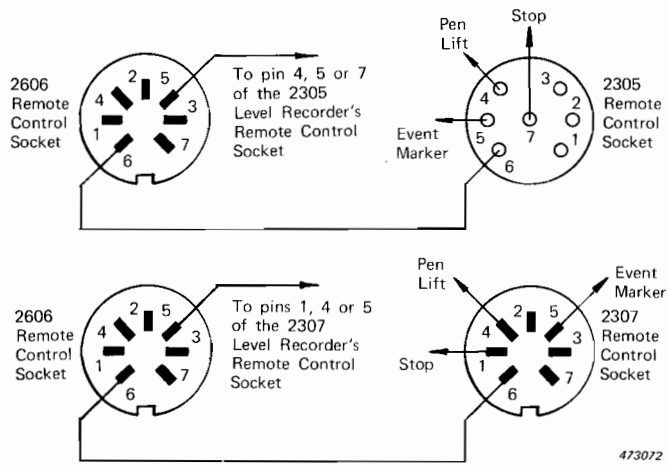

Fig.3.5. OVERLOAD SOCKET connections to the REMOTE CONTROL socket of a 2305 or 2307 Level Recorder, for operation of the Recorder's pen lift, event marker or auto-stop facility

3.9.2. Use with the 1612 Filter Set

On occasions when it is required to use the Third Octave Filter Set Type 1612 with the 2606 and a Level Recorder is not available to power the output amplifier of the Filter Set, then the + 20 Volt supply of the 2606 may be used. This is available at pin 4 of the OVERLOAD SOCKET, whilst the power input to the 1612 is via pin 5 of its REMOTE CONTROL socket. The negative return for the supply is via the screens of the coaxial cables used to connect the INPUT and OUTPUT sockets of the 1612 to the EXTERNAL FILTER INPUT AND OUTPUT sockets of the 2606.

4. CHARACTERISTICS

The measurement characteristics of the 2606 will be discussed with reference to the block diagram of the instrument shown in Fig.4.1.

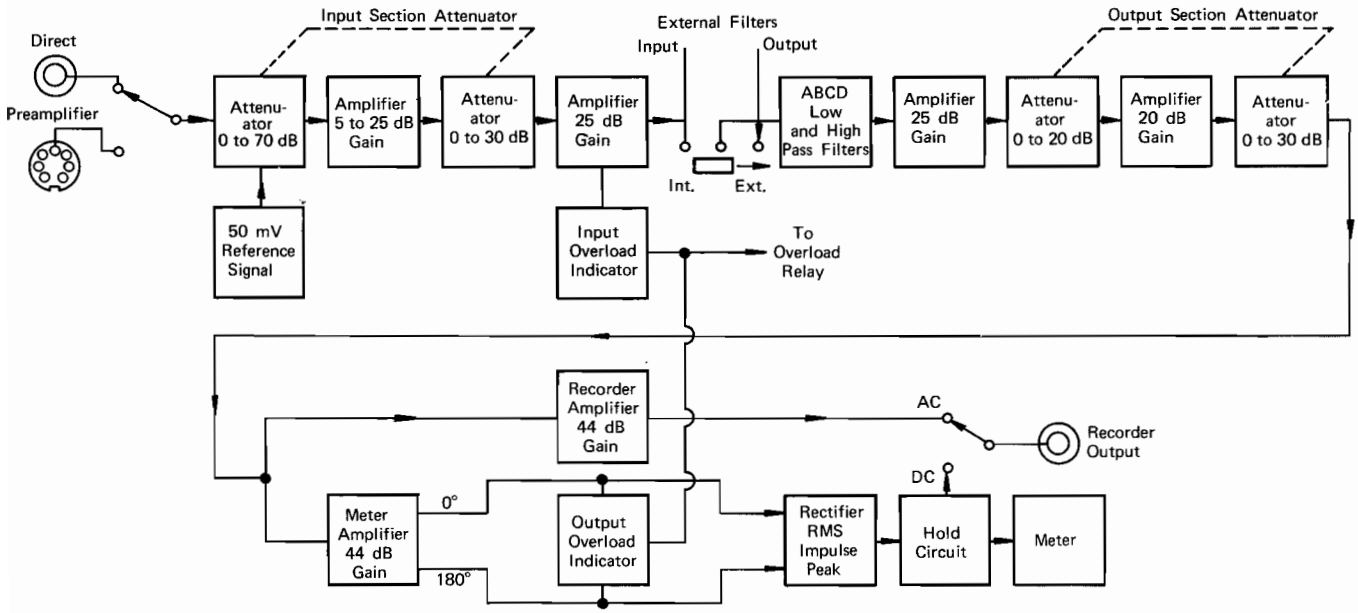

Fig.4.1. Block diagram of the 2606 Measuring Amplifier

4.1. RMS MEASUREMENT

Circuits for extracting the RMS value of a signal consists in principle of squaring, averaging and root extraction sections as shown in Fig.4.2. Brüel and Kjær RMS circuits, however, modify this general principle by using a squaring section with a variable squaring characteristic which eliminates the need of a separate square root operation. To illustrate this principle a schematic of the RMS circuit of the 2606 is shown in Fig.4.3.

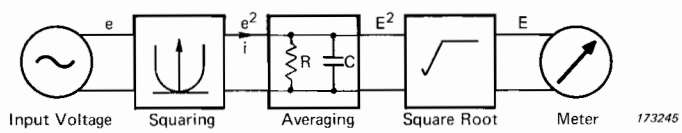

Fig.4.2. General principle of RMS rectifier circuits

In the 2606, the variable squaring characteristic is obtained by feeding back the voltage E on the averaging capacitor C_A to the squaring circuit. When the input signal voltage e (in the actual circuit e is the in-phase and 180° out of phase signal from the Meter Amplifier. See Fig.4.1), exceeds the level of the voltage on the averaging capacitor the

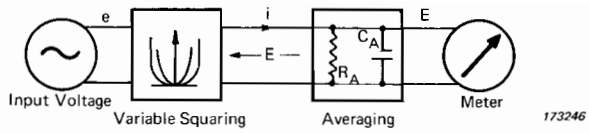

Fig.4.3. Principle of the RMS rectifier circuit used in the 2606

squaring circuit conducts, rectifying the signal, to charge the averaging capacitor. At the same time the squaring circuit compares the instantaneous value of the input voltage with the voltage across the averaging capacitor and depending on the difference in magnitude between the two voltages switches in different values of resistances to alter the charging current I_C applied to the capacitor. The magnitude of the resistors is set so that the slope of the circuit's charging current versus instantaneous input voltage curve increases in a series of limbs to approximate a parabola which is the characteristic required for squaring. This is illustrated by the full or half scale deflection curve shown in Fig.4.4,

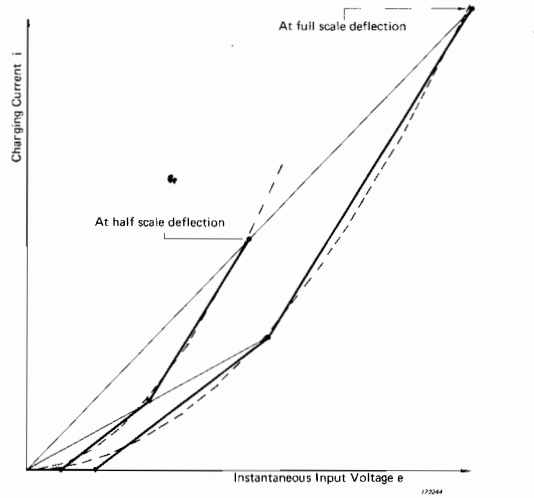

Fig.4.4. Squaring function of the RMS circuit of the 2606

in which the slope of each inclined line is due to a different value of resistance being switched in. To improve the approximation to a parabola a high instantaneous levels of input voltage a total of eight limbs are used. This permits the 2606 to measure signals with crest factors up to 10 with an accuracy of 0,5 dB at full scale, whilst for lesser meter deflections, signals with crest factors up to 40 can be measured (see Fig.4.5 and Table 4.1).

METER DEFLECTION (dB scale)	CREST FACTOR		
	less than 10	10 to 20	20 to 40
–10 to –2	± 1 dB	± 1,5 dB	± 2 dB
–2 to + 10	± 0,5 dB	± 1 dB	± 1,5 dB

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Table 4.1. Accuracy of the RMS meter indications of the 2606 as a function of meter deflection

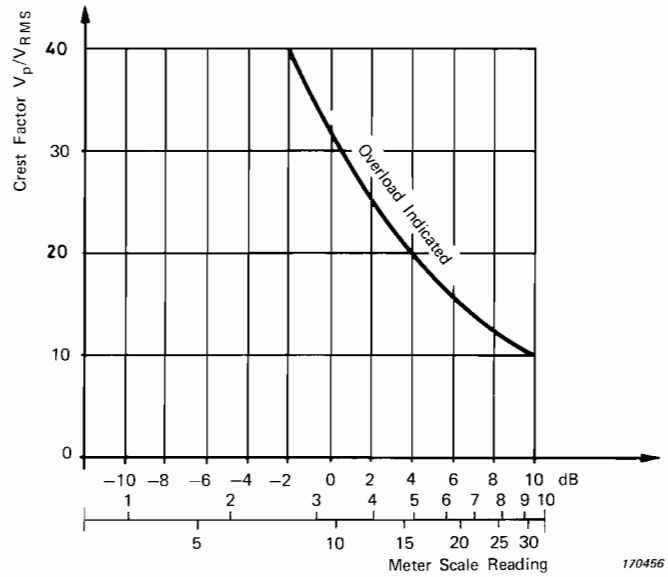

Fig.4.5. Crest factor capability of the RMS circuit of the 2606, as a function of signal crest factor and meter deflection

As the instantaneous level of the input voltage increases and the averaging capacitor is charged, the voltage across the averaging capacitor is also increased. This alters the difference in magnitude between the two voltages causing the squaring circuit to switch in resistances at different instantaneous input voltage levels, which results in a displacement of the circuit's squaring characteristic. The whole effect is equivalent to a multiplication of the parabola's size by a factor equal to that by which the voltage on the averaging capacitor is changed. By comparing the full and half scale deflection curves of Fig.4.4, it can be seen that this corresponds to a root extraction, as the charging current is now proportional to the input voltage. Consequently the circuit's output is linear even though its instantaneous voltage characteristic is a parabola.

At the same time as the averaging capacitor is charged, a discharge current proportional to the voltage across the averaging capacitor flows through the averaging resistor R_A. Therefore as long as the voltage on the averaging capacitor remains approximately constant (to within ± 0,5 dB) for a period of time equal to on exceeding the time constant of the averaging network (C_A in parallel with R_A the charging current can be considered proportional to the RMS value of the input voltage.

For RMS measurements the averaging circuit of the 2606 has two averaging time constants which may be selected using the METER FUNCTION switch to give "Fast" and "Slow" meter damping characteristics in accordance to the IEC Recommendation 179-1965 for precision level meters. In the "Fast" mode of the switch a 100 ms averaging time constant is used which is sufficiently long for signals with frequency components down to 10 Hz to be averaged with less than ± 0,5 dB of ripple on the RMS value indicated by the meter. For averaging of signals with frequency components down to 2 Hz a 500 ms averaging time constant is used when the "Slow" mode of the switch is selected.

For further details on the principle of B & K RMS rectifier circuits, as well as their differences from convention types, the Brüel & Kjær Technical Review No. 1, 1969 ("Impulse Noise Measurements" by C.G. Wahrmann) should be consulted.

4.2. IMPULSE MEASUREMENT

The problem of how to produce a meter indication which reliably gives a subjective impression of the loudness of short duration sounds (durations ranging from 1 to 100 ms) has for many years been a research topic of considerable interest. The difficulty lies in the specification of a meter response characteristic which closely approaches the rise time of the human ear and stores averages and forgets the short duration signal in a similar manner to the human brain. In an attempt to simulate this response the 2606 is provided with an "Impulse" METER FUNCTION switch mode in which an averaging time constant giving a 35 ms rise time is used in the RMS circuit and the output of the circuit applied to a Meter Hold circuit containing a 3 s ± 0,5 s decay time constant. This is in accordance with the German DIN Standard 45633 and the proposed extension to IEC 179 for impulse sound level meters. Both standards are similar and in attempting to standardize a desirable impulse response recommend certain measurement characteristics for the instrument as a whole. The "Impulse" mode of the 2606 complies to these characteristics which are summarized as follows:

For a single sinusoidal tone burst, having a frequency of 2 Hz, a duration t, and a constant amplitude, the reading relative to the reading for the continuous signal shall be as stated in Table 4.2.

Tone Burst duration t ms	Reading with respect to reading of continuous signal dB	Tolerance dB
continuous	0	
50	−1,2	± 1
20	−3,6	± 1,5
10	−6,0	± 2
5	−8,8	± 2
2	−12,6	± 2

072093

Table 4.2. Impulse sound level meter response requirements for single impulses

Repetition frequency f_p Hz (c/s)	Reading with respect to reading of continuous signal dB	Tolerance dB
continuous	0	
100	−2,7	± 1
50	−5,1	± 0,5
20	−7,6	± 2
10	−8,5	± 2
5	−8,7	± 2
2	−8,8	± 2

072088

Table 4.3. Impulse sound level meter response requirements for repeated impulses

For a sinusoidal signal having a frequency of 2 Hz, a duration of 5 ms, repetition frequency f_p and a constant amplitude, the reading relative to the reading for the continuous signal shall be as stated in Table 4.3.

Besides an "Impulse" mode the 2606 is also provided with an "Impulse Hold" METER FUNCTION mode. Although this facility is not covered by the IEC or DIN Standards, measurements made with the "Impulse" and "Impulse Hold" mode of the 2606, using the test conditions specified by the standards, give rise to identical meter readings. This is because the meter reading for "Impulse" and "Impulse Hold" measurements is determined purely by the peak value of the voltage on the RMS circuits averaging capacitor, the time constant of which is the same for both types of measurement. The measurement of single impulses will, however, be more easily carried out using the "Impulse Hold" mode, since the decay of the voltage on the storage capacitor used in the Meter Hold circuit is less than 0,05 dB/s at 25°C in this mode. To reset the "meter indication after an Impulse Hold" measurement has been made a METER RESET push-button is provided.

4.3. PEAK MEASUREMENT

The behaviour of the RMS Circuit of the 2606 is very much dependent on the time constant of its averaging network and the period of the signal waveform measured. If the voltage to which the time constant is charged remains approximately constant for a period of time equal to or exceeding the value of the time constant, then correct averaging will have taken place and the output of the RMS circuit will be proportional to the RMS value of the measured signal. For this to occur the value of the time constant must be larger than the period of the measured signal waveform. If not correct averaging will not take place, but instead the voltage on the time constant will follow the positive or negative peaks (whichever is the greatest) of the rectified signal waveform. This fact is made use of for the "Peak Hold" METER FUNCTION mode of the 2606, which when selected connects a 10 μs time constant into the RMS circuit and "holds" the maximum value of the RMS circuits output using the Meter Hold circuit, thus extracting the maximum peak value of the measured signal. With such a short time constant single pulses with durations as short as 20 μs may be measured with an accuracy of ± 0,5 dB. The decay of the peak meter reading obtained is less than 0,05 dB/s and is determined by the decay time constant of the Meter Hold circuit.

4.4. FREQUENCY RESPONSE

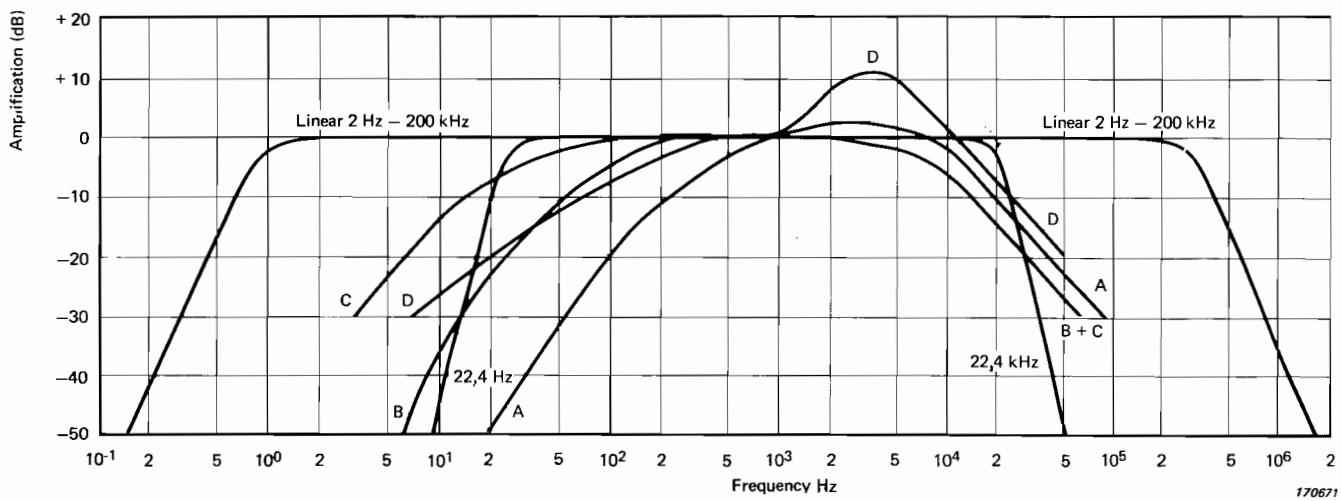

Fig. 4.6. Frequency characteristics of the 2606

The frequency response of the 2606 is linear to within ± 0,5 dB from 2 Hz to 200 kHz as shown in Fig.4.6. However, for various audio measurements it is sometimes convenient to limit frequencies at either end or both ends of the pass band to prevent high and low frequency components of the input signal from influencing the measurement. For this purpose the 2606 is provided with separate high and low pass filter networks which have cut off frequencies of 22,4 Hz and 22,4 kHz respectively. Both filters are active networks and have an attenuation slope of 18 dB/octave, in accordance with the IEC Recommendation 225. Their frequency characteristics are shown in Fig.4.7.

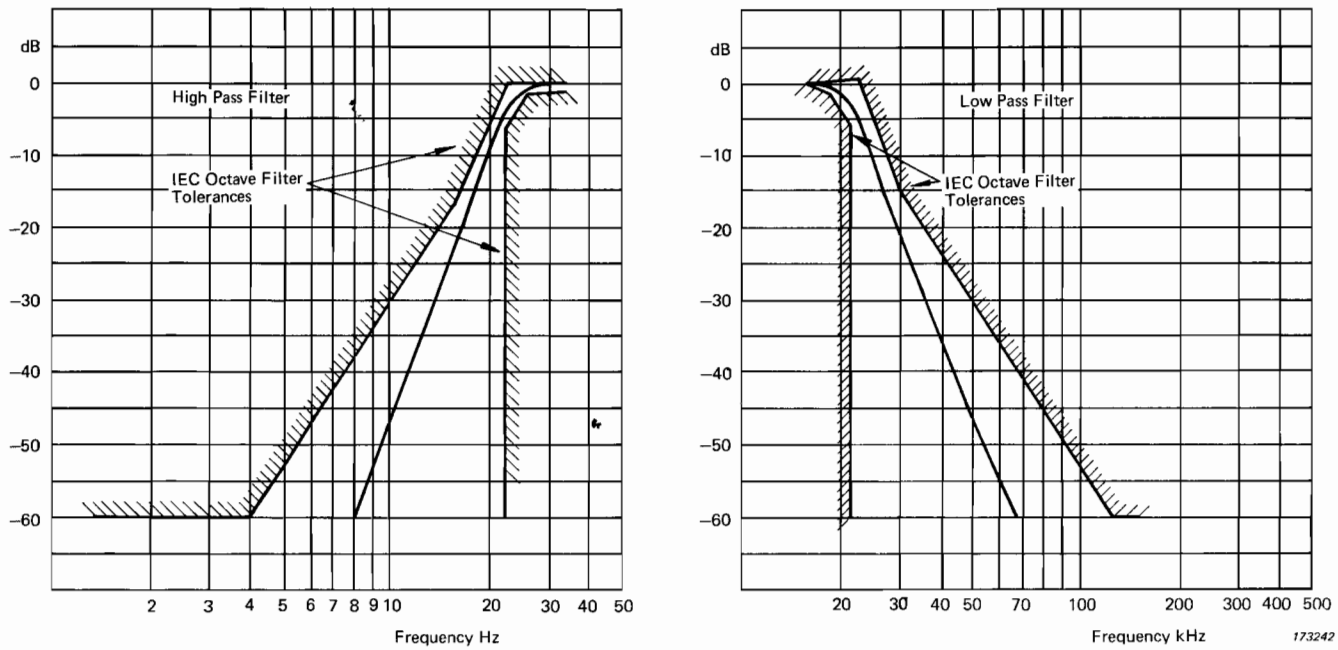

Fig.4.7. Frequency characteristics of the low and high pass filters

For sound level measurements, the 2606 also contains A, B, C and D weighting networks which are used to obtain a subjective indication of the loudness of measured sounds. Their frequency characteristics comply with the basic shape and tolerances given in Table 4.4 and are those laid down by the proposed amendments (September 1971 for A, B and C weightings and July 1970 for the D weighting) to the IEC Recommendation 179 for precision sound level meters. It should be noted that the tolerances given are only valid for the complete instrument with the microphone and preamplifier in a free sound field, with normal incidence of sound pressure waves on the microphones diaphragm.

4.5. PHASE RESPONSE

The phase response of the 2606, from the DIRECT or PREAMPLIFIER INPUT to the RECORDER output when the OUTPUT SELECTOR is set to "AC" is shown in Fig.4.8. From this it can be seen that as with most amplifiers the 2606 suffers from phase distortion both at high and low frequencies. At low frequencies the response is determined by the phase characteristics of the AC coupling networks used, whilst at high frequencies it is determined by the phase characteristics of the Output Section's low pass filter, which ensures a well defined cut off frequency (315 kHz) for all attenuator settings. The maximum phase difference between any two 2606 Measuring Amplifiers is ± 5° from 5 Hz to 20 kHz.

Frequency Hz	Curve A dB	Curve B dB	Curve C dB	Tolerance Limits (dB) for Curves A, B and C		Curve D dB	Tolerance Limits (dB) for Curve D	
10	−70,4	−38,2	−14,3	3	−∞	−26,5	3,5	−∞
12,5	−63,4	−33,2	−11,2	3,0	−∞	−24,5	3,5	−∞
16	−56,7	−28,5	− 8,5	3,0	−∞	−22,5	3,5	−∞
20	−50,5	−24,2	− 6,2	3,0	−3,0	−20,5	3,5	−3,5
25	−44,7	−20,4	− 4,4	2,0	−2,0	−18,5	2,5	−2,5
31,5	−39,4	−17,1	− 3,0	1,5	−1,5	−16,5	2,0	−2,0
40	−34,6	−14,2	− 2,0	1,5	−1,5	−14,5	2,0	−2,0
50	−30,2	−11,6	− 1,3	1,5	−1,5	−12,5	2,0	−2,0
63	−26,2	− 9,3	− 0,8	1,5	−1,5	−11	2,0	−2,0
80	−22,5	− 7,4	− 0,5	1,5	−1,5	− 9	2,0	−2,0
100	−19,1	− 5,6	− 0,3	1,0	−1,0	− 7,5	1,5	−1,5
125	−16,1	− 4,2	− 0,2	1,0	−1,0	− 6,0	1,5	−1,5
160	−13,4	− 3,0	− 0,1	1,0	−1,0	− 4,5	1,5	−1,5
200	−10,9	− 2,0	0	1,0	−1,0	− 3,0	1,5	−1,5
250	− 8,6	− 1,3	0	1,0	−1,0	− 2,0	1,5	−1,5
315	− 6,6	− 0,8	0	1,0	−1,0	− 1,0	1,5	−1,5
400	− 4,8	− 0,5	0	1,0	−1,0	− 0,5	1,5	−1,5
500	− 3,2	− 0,3	0	1,0	−1,0	0	1,5	−1,5
630	− 1,9	− 0,1	0	1,0	−1,0	0	1,5	−1,5
800	− 0,8	0	0	1,0	−1,0	0	1,5	−1,5
1000	0	0	0	1,0	−1,0	0	1,5	−1,5
1250	0,6	0	0	1,0	−1,0	2,0	1,5	−1,5
1600	1,0	0	− 0,1	1,0	−1,0	5,5	1,5	−1,5
2000	1,2	− 0,1	− 0,2	1,0	−1,0	8,0	1,5	−1,5
2500	1,3	− 0,2	− 0,3	1,0	−1,0	10	1,5	−1,5
3150	1,2	− 0,4	− 0,5	1,0	−1,0	11	1,5	−1,5
4000	1,0	− 0,7	− 0,8	1,0	−1,0	11	1,5	−1,5
5000	0,5	− 1,2	− 1,3	1,5	−1,5	10	2,0	−2,0
6300	− 0,1	− 1,9	− 2,0	1,5	−2,0	8,5	2,0	−2,5
8000	− 1,1	− 2,9	− 3,0	1,5	−3,0	6,0	2,0	−3,5
10000	− 2,5	− 4,3	− 4,4	2,0	−4,0	3,0	2,5	−4,5
12500	− 4,3	− 6,1	− 6,2	3,0	−6,0	0	3,5	−6,5
16000	− 6,6	− 8,4	− 8,5	3,0	−∞	− 4,0	3,5	−∞
20000	− 9,3	−11,1	−11,2	3,0	−∞	− 7,5	3,5	−∞

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Table 4.4. Weighting network characteristics and tolerances, in accordance with the proposed amendments to the IEC Recommendation 179

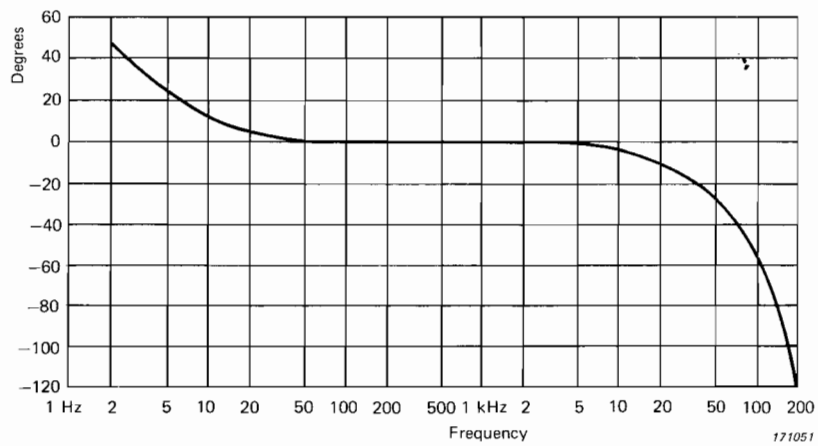

Fig. 4.8. Phase response of the 2606

When the built-in 22,4 Hz high pass filter and the 22,4 kHz low pass filter are selected the phase response of the 2606 is as shown in Fig.4.9. In this case the phase characteristics of the filters chiefly determine the response.

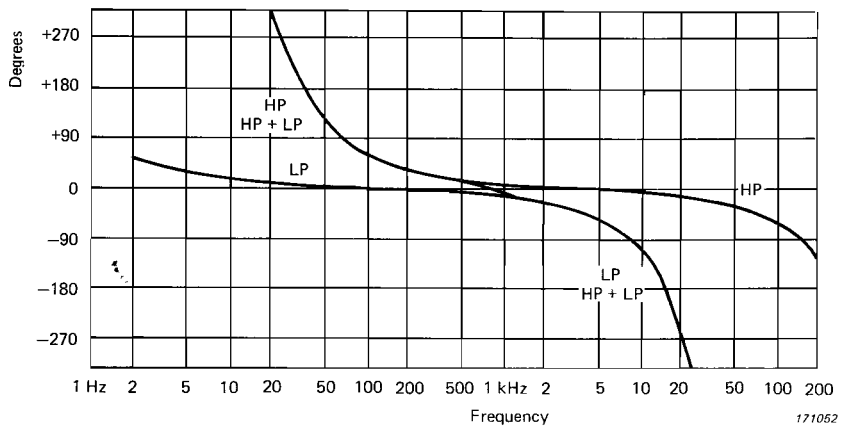

Fig.4.9. Phase response of the 2606 when the 22,4 Hz high pass filter and the 22,4 kHz low pass filter are selected

For RMS measurements the phase response of the 2606 will not influence the measurement accuracy since any change in phase relationship between different components of the signal will not affect its RMS value. This also applies for impulse and peak measurements provided that the signal is sinusoidal and does not contain any phase related frequency components. However, if the signal is complex and does contain phase related frequency components (as in the case of a square wave signal) the measurement accuracy will be affected.

To illustrate the effects of phase distortion on a complex signal, a symmetrical square wave signal was applied to the input of the 2606, to produce the output waveforms shown in Fig.4.10. Fig.4.10(a) shows the effect of "sag", which is due to the low frequency phase response of the 2606 causing the low frequency components of the signal to phase lead the fundamental. The amount of sag produced is proportional to the duration of the low frequency components and therefore for a symmetrical square wave signal will decrease as the signals repetition frequency is increased. Measurements show that the influence of "sag" on a square wave signal with repetition frequency of 2 Hz can introduce errors of up to + 4 dB in the meter indication obtained with the "Impulse" and "Impulse Hold" modes of the 2606. However, when the repetition frequency of the signal is increased to 20 Hz or above, "Impulse" and "Impulse Hold" meter indications can be obtained with less than + 0,5 dB error, as the effect or "sag" on the signal waveform is much less pronounced.

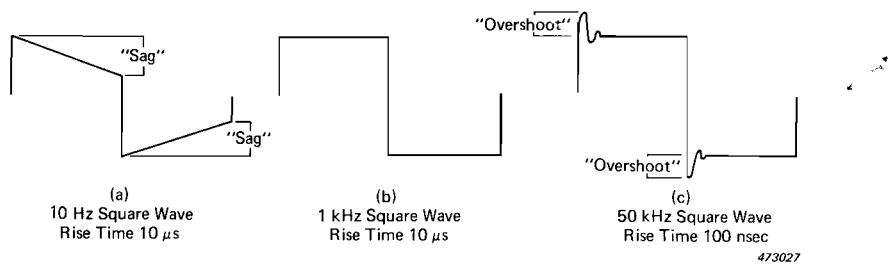

Fig.4.10. Influence of phase distortion on a symmetrical square wave. The waveforms are measured at the RECORDER output of the 2606 when the OUTPUT MODE selector is set to "AC"

For "Peak Hold" measurements on very low frequency square wave signals or on single impulses, "sag" will also occur, but will not influence the meter indication provided that the repetition frequency of the signal is lower than 0,01 Hz. This means that when measurements on single impulses are made, a minimum time of 10 seconds must be allowed between the measurement of each impulse. The accuracy of the Peak Hold indication obtained will then be within 0,5 dB.

Fig.4.10(c) shows the effect of overshoot which is due to the high frequency phase response of the 2606 causing high frequency components of a square wave signal to phase lag the fundamental. For "Peak Hold" measurements on single impulses overshoot can cause considerable measurement errors, but can be avoided by ensuring that the rise time of the signal does not exceed 10 μs. For Impulse and Impulse Hold measurements overshoot is not a problem as the RMS value of the signal is first extracted to obtain a meter indication.

4.6. GAIN

Together with the Recorder Amplifier the four amplifier stages of the Input and Output Sections give the 2606 a high overall gain of 114 dB. This is obtained with the INPUT AND OUTPUT SECTION ATTENUATORS of the instrument set to "3 mV" and "X 0,003" respectively and is the gain from the DIRECT or PREAMP. INPUT to the RECORDED output when the OUTPUT MODE selector is set to "AC". For other settings of the INPUT AND OUTPUT SECTION ATTENUATORS the overall AC gain of the 2606 is as shown in Table 4.5.

INPUT SECTION ATTENUATOR	OUTPUT SECTION ATTENUATOR					
	x 0,003	x 0,01	x 0,03	x 0,1	x 0,3	x 1
3 mV	120	110	100	90	80	70
10 mV	110	100	90	80	70	60
30 mV	100	90	80	70	60	50
0,1 V	90	80	70	60	50	40
0,3 V	80	70	60*	50	40	30
1 V	70	60	50	40	30	20
3 V	60	50	40	30	20	10
10 V	50	40	30	20	10	0
30 V	40	30	20	10	0	−10
100 V	30	20	10	0	−10	−20
300 V	20	10	0	−10	−20	−30

072091

Table 4.5. Overall gain from the DIRECT or PREAMP. input to RECORDER output of the 2606 when the OUTPUT MODE selector is set to "AC"

4.7. DYNAMIC RANGE

The dynamic range of the 2606 is not only determined by the various amplifier and rectifier sections of the instrument, but also by the setting of its INPUT AND OUTPUT SECTION ATTENUATORS. For measurements using the AC output of the RECORDER socket with the linear 2 Hz to 200 kHz mode or the D weighting network selected, the dynamic range is as given in Table 4.6.

OUTPUT SECTION ATTENUATOR	INPUT SECTION ATTENUATOR		
	3 mV	10 mV	30 mV – 300 V
x 0,003	> 10 dB	> 20 dB	> 30 dB
x 0,01	> 20 dB	> 30 dB	> 40 dB
x 0,03	> 30 dB	> 40 dB	> 50 dB
x 0,1	> 40 dB	> 50 dB	> 60 dB
x 0,3	> 50 dB	> 60 dB	> 70 dB
x 1	> 60 dB	> 70 dB	> 80 dB

072094

Table 4.6. Dynamic range of the AC output from the RECORDER socket of the 2606 when the 2 Hz to 200 kHz linear mode or the D weighting network is selected

When the 22,4 kHz low pass filter network or one of the A, B, and C weighting networks is selected, relatively high frequency noise components produced in the input section amplifiers of the 2606 are attenuated by the network. This effectively increases the dynamic range of the 2606 by a further 10 dB as shown in Table 4.7. No increase is obtained with the 300 V range of the 2606 as this already has a dynamic range of 80 dB which is approximately the same as that of the filters themselves.

For measurements using the DC output of the RECORDER socket the dynamic range is chiefly determined by the RMS Rectifier and Meter Hold circuits of the 2606 and is as given in Fig.4.11. However, when the more sensitive ranges of the 2606 are selected using the INPUT AND OUTPUT SECTION ATTENUATORS, then the dynamic range of the amplifier sections must also be considered (see Tables 4.6 and 4.7).

OUTPUT SECTION ATTENUATOR	INPUT SECTION ATTENUATOR		
	3 mV	10 mV	30 mV – 300 V
x 0,003	> 20 dB	> 30 dB	> 40 dB
x 0,01	> 30 dB	> 40 dB	> 50 dB
x 0,03	> 40 dB	> 50 dB	> 60 dB
x 0,1	> 50 dB	> 60 dB	> 70 dB
x 0,3	> 60 dB	> 70 dB	> 80 dB
x 1	> 70 dB	> 80 dB	> 80 dB

072089

Table 4.7. Dynamic range of the AC output from the RECORDER socket or the 2606 when the 22,4 kHz low pass filter or one of the A, B or C weighting networks is selected

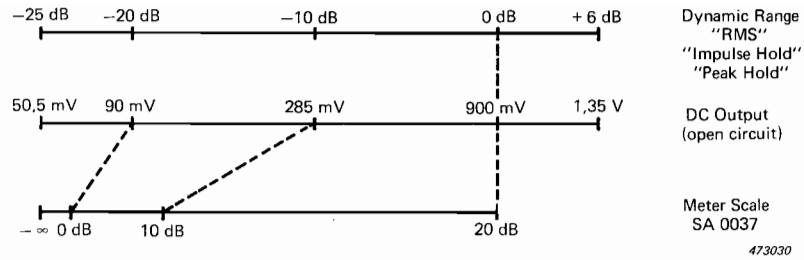

Fig. 4.11. Dynamic range of the DC output from the RECORDER socket of the 2606 for RMS, Impulse and Peak METER FUNCTION modes, as a function of scale reading and output voltage

5. ACCESSORIES

5.1. GENERAL

The combinations of accessories that can be used with the 2606 can be seen in Fig. 5.1 and 5.2. The specifications of these accessories can be found in the B & K Short and Main Catalogues which are available through your B & K agent.

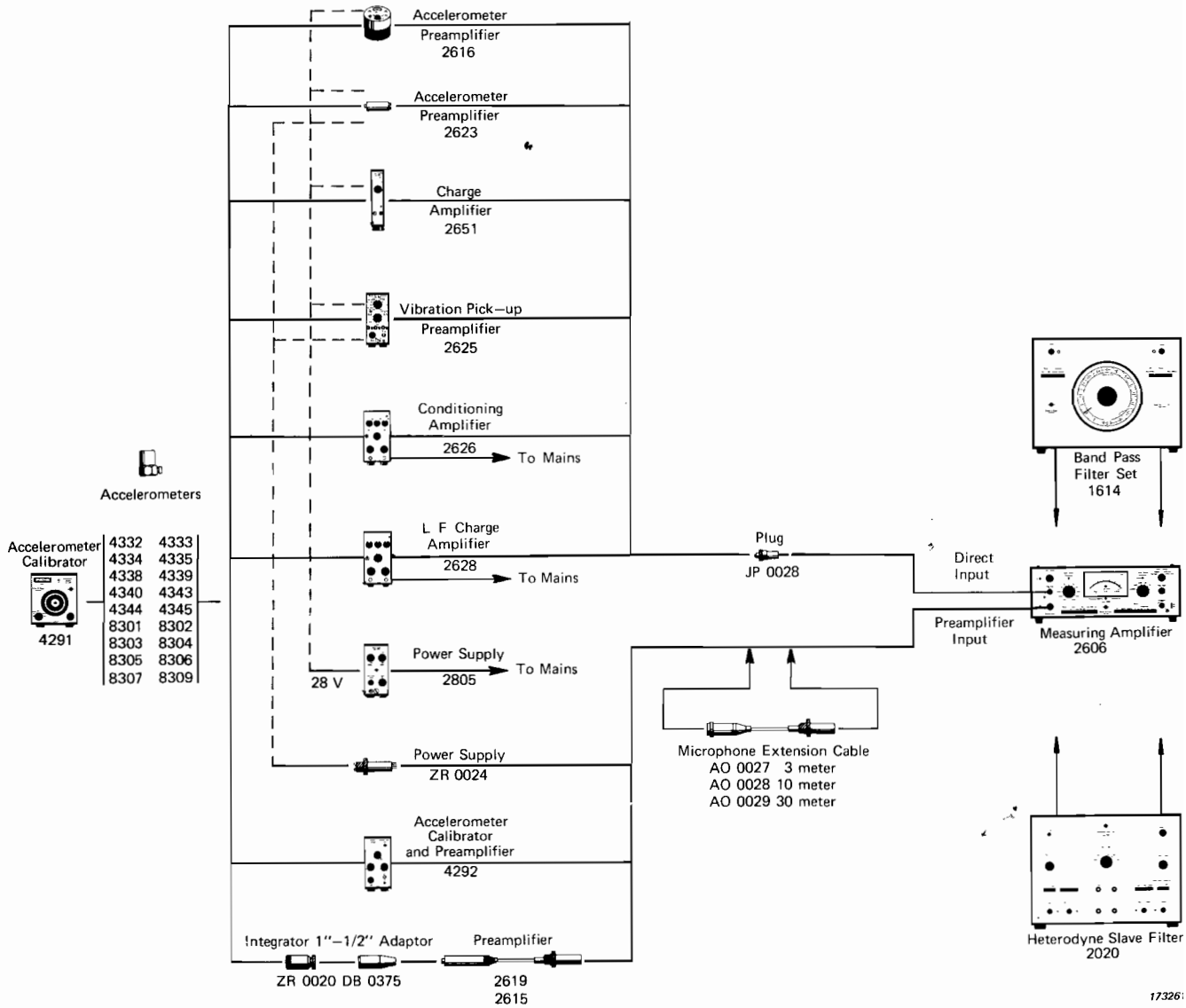

Fig. 5.1. Accessories for measurement of vibration with the 2606

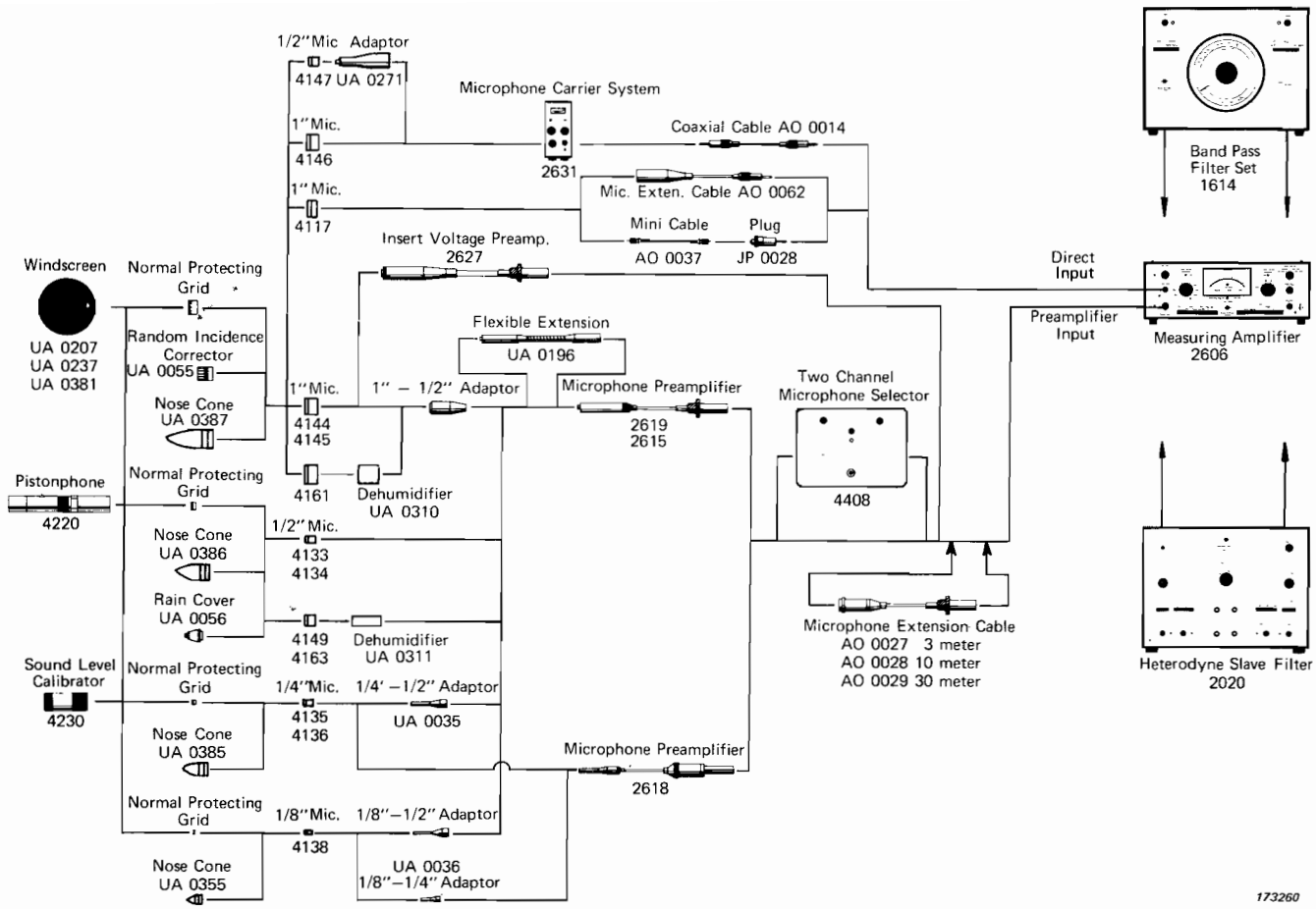

Fig. 5.2. Accessories for measurement of sound with the 2606

5.2. RACK MOUNTINGS

The 2606 is available in "A", "B" and "C" models. Model "A" is the standard version and is the 2606 in a light metal cabinet which with the addition of a mahogany case KA 0026 makes the "B" model, or alternatively with the addition of a 19 inch metal rack mounting frame KS 0014 makes the "C" model. Both the mahogany case and the metal rack mounting frame are available separately.

For mounting together a combination of B & K instruments, rack KQ 0077 accepts the 2606 together with the Beat Frequency Oscillator 1022 (or Sine-Random Generator 1024), the Heterodyne Slave Filter 2020, and the Level Recorder 2305. Rack KA 0078 is also available for mounting the 2606 and Level Recorder 2305 together with the Beat Frequency Oscillator 1022, or the Sine Random Generator 1024, or the Tape Recorder 7001.

Details of the rack types available and the mounting procedure are given in a special Assembly Manual for the KA, KQ and KS types.

5.3. METER SCALES

The full range of interchangeable meter scales available for B & K measuring equipment are given in Table 5.1, whilst those for use with the 2606 are given in Table 5.2.

Scale No.	Instrument Type	Purpose of scale
SA 0023	2007	Blank plate
SA 0028	2010, 2113, 2114, 2120, 2121, 2130, 2606, 2607, 2609	Blank scale without markings
SA 0033	2426	Blank scale without markings
SA 0037	2606, 2113, 2130	Volts, dB
SA 0038	2606, 2113, 2130	Volts, dB re 1 μV
SA 0039	2606, 2113, 2130	dB SPL (28 — 160 mV /Pa)
SA 0040	2606, 2113, 2130	dB SPL (5 — 30 mV /Pa)
SA 0042	All instruments here except 2007	Blank plate
SA 0045	2606, 2113, 2130	Absorption Coeff. %
SA 0046	2606, 2113, 2130	PSD, V^2/Hz
SA 0051	2607, 2114, 2010, 2120	Volts, dB (Lin)
SA 0052	2607, 2114, 2010, 2120	dB re 1 μV, Volts (Lin)
SA 0053	2607, 2114, 2010, 2120	dB re 1 μV, Volts (Log)
SA 0054	2607, 2114, 2010, 2120	Absorption Coeff. % (Lin)
SA 0055	2607, 2114, 2010, 2120	PSD, V^2/Hz (Lin)
SA 0056	2607, 2114, 2010, 2120	dB SPL (28 — 160 mV /Pa) (Lin)
SA 0057	2607, 2114, 2010, 2120	dB SPL (5 — 30 mV /Pa) (Lin)
SA 0058	2607, 2114, 2010, 2120	Accel. g (6 — 17 mV/g) (Lin)
SA 0059	2607, 2114, 2010, 2120	dB re 1 μV Lin & Log
SA 0060	2607, 2114, 2010, 2120	dB SPL (0,8 — 5 mV /Pa) (Lin)
SA 0061	2606, 2113, 2130	dB SPL (0,8 — 5 mV /Pa)
SA 0062	2510	RMS Velocity inch/s
SA 0063	2510	RMS Velocity mm/s
SA 0070	2606, 2113, 2130	Accel. g (17 — 60 mV/g)
SA 0071	2606, 2113, 2130	Accel. g (6 — 17 mV/g)
SA 0073	2606, 2113, 2130	dB SPL (0,28 — 1,6 mV /Pa)
SA 0074	2606, 2113, 2130	Accel. g (1,7 — 6 mV/g)
SA 0075	2606, 2113, 2130	Accel. g (60 — 170 mV/g)
SA 0076	2021	Volts, dB
SA 0077	2606, 2113, 2130	Volts, dB re 1 V, dBm
SA 0078	2021	PSD, V^2/Hz
SA 0079	2021	PSD, g^2/Hz (10 mV/g)
SA 0080	2021	Accel. g (10 mV/g)
SA 0081	2021	0 — 100 blank scale & dB
SA 0082	2021	Blank scale without markings
SA 0083	2607, 2114, 2010, 2120	dB SPL (0,28 — 1,6 mV /Pa) (Lin)
SA 0084	2607, 2114, 2010, 2120	Volts, dB re 1 V, dBm (Lin)
SA 0086	2606, 2113, 2130	0 — 100 blank scale
SA 0087	2607, 2114, 2010, 2120, 2121	0 — 100 blank scale
SA 0091	2606, 2113, 2130	dB SPL (8 — 50 mV /Pa)
SA 0092	2606, 2113, 2130	dB SPL (2,6 — 16 mV /Pa)
SA 0098	2007, 2510, 2425, 2609	Blank scale without markings
SA 0142	2607, 2114, 2010, 2120	Accel. g (1,7 — 6 mV/g) (Lin)
SA 0143	2607, 2114, 2010, 2120	Accel. g (17 — 60 mV/g) (Lin)
SA 0144	2607, 2114, 2010, 2120	Accel. g (60 — 170 mV/g) (Lin)
SA 0155	2007	Frequency MHz
SA 0156	2007	American TV Channels
SA 0157	2007	European TV Channels
SA 0158	2606, 2113, 2130	Displacement m (32 — 100 mV/g)
SA 0159	2606, 2113, 2130	Velocity m/s (32 — 100 mV/g)
SA 0162	2425	Volts, dB re 1 V
SA 0163	2425	Volts, dB re 1 V, dBm
SA 0165	2426	Volts, dB
SA 0166	2426	dB re 1 Volt, dBm
SA 0167	2007	Volts, % kHz Modulation, dB
SA 0168	2425	vu, dB re 0,775 V
SA 0169	2426	vu, dB re 0,775 V
SA 0171	2426	Volts, dB re 1 μV
SA 0174	2121	Volts, dB
SA 0175	2121	dB SPL (28 — 160 mV /Pa)
SA 0176	2121	dB SPL (5 — 30 mV /Pa)
SA 0178	2607, 2114, 2010, 2120	dBm Log & Lin
SA 0179	2609	dB SPL (6,4 — 30 mV /Pa)
SA 0180	2609	dB SPL (28 — 160 mV /Pa)
SA 0181	2609	Volts, dB re 1 μV
SA 0182	2609	0 — 100 blank scale

073007

Table 5.1. Meter scales for B & K Measuring equipment

Purpose	Sound Pressure Level dB re 20 μPa					Acceleration g			
Transducer	Condenser Microphone					Accelerometer			
Type	1" 4144 4145/61 4146	1/2" 4133/63 4134 4147 4149	1/4" 4135	1/4" 4136	1/8" 4138	4338	4332 4334	4333 4335 4339 4340 4343 8301 8302	4344 8303
Transducer Sensitivity	~ 50 mV/Pa	~ 12,5 mV/Pa	~ 4 mV/Pa	~ 1,6 mV/Pa	~ 1 mV/Pa	~ 100 mV/g	~ 50 mV/g	~ 12,5 mV/g	~ 2 mV/g
Scale No.	SA 0039	SA 0040 (SA 0091)	(SA 0092)	(SA 0061)	(SA 0061) (SA 0073)	(SA 0075)	**(SA 0070)**	SA 0071	(SA 0074)

Purpose	Velocity	Displacement	Volt lin	dB re 1 μV lin	dB re 1V lin	dBm	P.S.D. V^2/Hz	Absorption Coeficient %	Grad 0–100
Transducer Type	Accelerometer 4332 4334 4338		–	–	–	–	–	–	–
Transducer Sensitivity	32 – 100 mV/g		–	–	–	–	–	–	–
Scale No.	(SA 0159)	(SA 0158)	SA 0037	SA 0038	(SA 0077)	(SA 0077)	(SA 0046)	(SA 0045)	SA 0086

072097

Table 5.2. Meter scales for use with the 2606. Scales with type numbers not indicated in brackets are those provided with the 2606

6. APPLICATIONS

6.1. LEVEL RECORDING

In the measurement of sound and vibration it is often important to study the level of a signal as it varies with time. For this purpose either AC or DC recording of the level variations may be recorded graphically using the 2606 together with a 2305 or 2307 Level Recorder. A typical recording arrangement is shown in Fig.6.1.

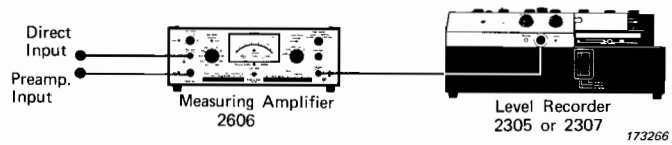

Fig.6.1. Instrument arrangement for level recording

6.1.1. AC Recording

For recording of continuous signals, with frequency components down to 2 Hz, AC recording is recommended as this makes best use of the dynamic range available with the Input and Output Section Amplifiers of the 2606. For the 10 mV to 300 V ranges of the INPUT SECTION ATTENUATOR the dynamic range available with the 2606 is greater than 70 dB and therefore the 2305 or 2307 Level Recorder may be used with the 75 dB, 50 dB, 25 dB or 10 dB logarithmic Range Potentiometers as well as the Linear Range Potentiometers. However, since the dynamic range of the 2606 is also dependent on the setting of its OUTPUT SECTION ATTENUATOR it is recommended to consult Tables 4.2 and 4.3 before selecting a suitable Range Potentiometer.

With AC recording the AC output of the RECORDER socket of the 2606 is used. Rectification and part of the averaging of the signal fluctuations is then performed electronically by the Rectifier Circuit of the Level Recorder with the remaining signal averaging taking place in the Recorder's writing system. The most influential control which affects averaging is the WRITING SPEED selector, but is also to some extent influenced by the setting of the LOWER LIMITING FREQUENCY control. Empirical data suggests that the effective averaging times as a function of WRITING SPEED may be represented by a double logarithmic plot as shown in Fig.6.2. There is, however, some spread in the data owing to LOWER LIMITING FREQUENCY settings as well as signal characteristics (e.g. crest factor, bandwidth etc.), and this is also indicated in Fig.6.2. The left hand limit of this spread is a theoretical limit corresponding with zero pen movement. For normal settings of the 2305 and 2307 Level Recorders and pen movements of 12 to 16 mm peak to peak for 100 mm writing widths (6 to 8 mm for 50 mm writing width), most of the effective averaging times will be in the shaded area of Fig.6.2. Fig.6.2 may be used with all Range Potentiometers.

The instrument arrangement used for AC recording is shown in Fig.6.1. The procedure used to set up the recording arrangement is given here with reference to a 2307 Level Recorder and a 50 dB Range Potentiometer. For use of a 2305 Level Recorder or other

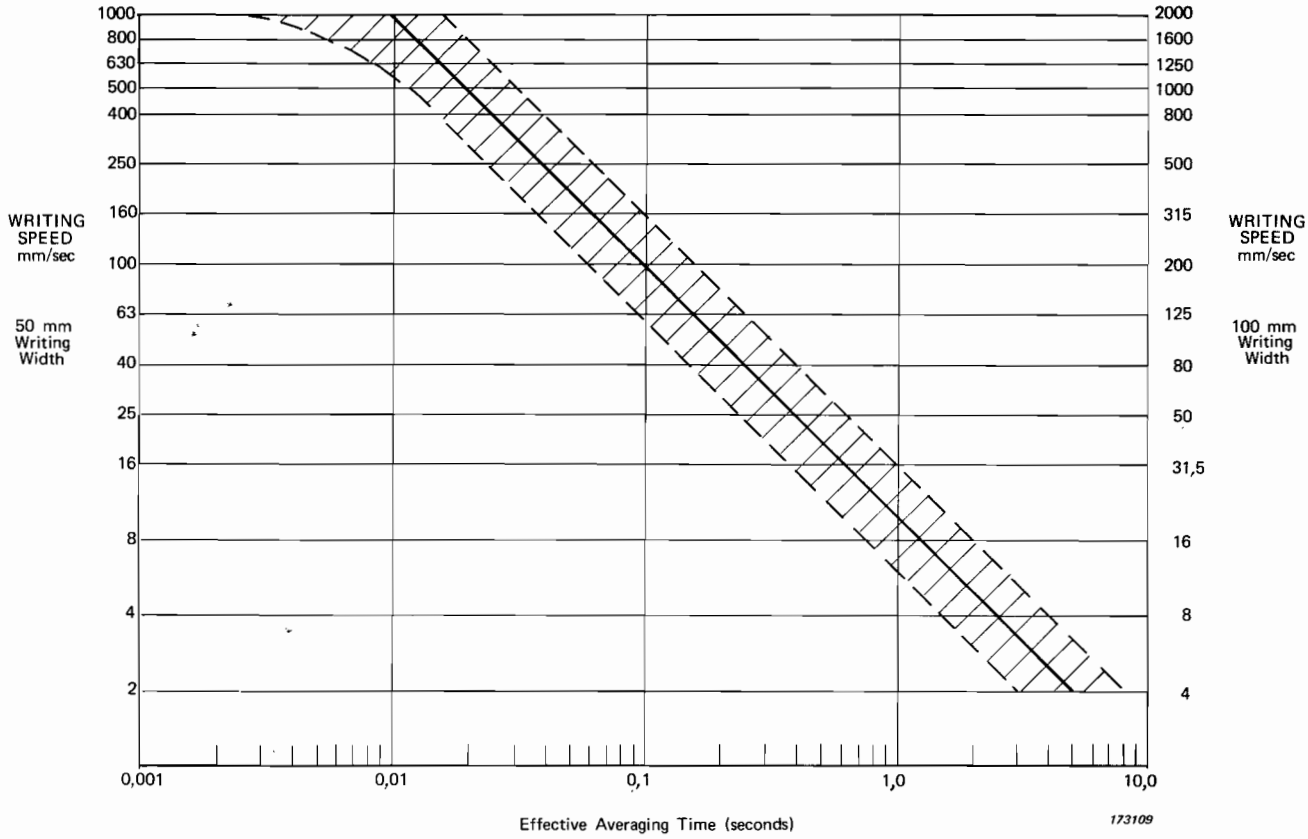

Fig.6.2. Effective averaging times as a function of writing speed

Range Potentiometers a similar procedure may be followed. The controls of the 2307 Level Recorder are shown in Fig.6.3.

To make an AC recording proceed as follows:

1. With the OUTPUT MODE switch of the 2606 set to "AC" connect the RECORDER OUTPUT socket of the 2606 to the INPUT socket of the 2307 Level Recorder.

2. Fit the 50 dB Logarithmic Range Potentiometer to the Recorder and insert the Recording Paper QP 1102.

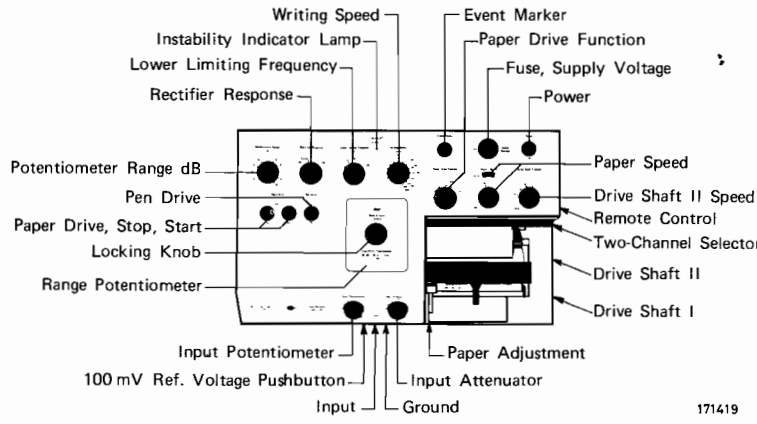

Fig.6.3. 2307 Level Recorder controls

3. Set the Level Recorder controls:

POTENTIOMETER RANGE	"50 dB"
RECTIFIER RESPONSE	"RMS"
PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	as required
PEN DRIVE	"On"
POWER	"On"

4. For AC recording averaging of small signal fluctuations (between 12 and 16 mm for 100 mm paper widths) is controlled by the WRITING SPEED selector of the 2305 or 2307 Level Recorder. To minimize ripple on the recording set the WRITING SPEED selector to 100 mm/s (large figures) for recording signals with components down to 10 Hz or to 31,5 mm/s for recording of signals with components down to 2 Hz. The effective averaging times obtained with these WRITING SPEED settings approximate the 100 ms averaging time of the "RMS Fast" METER FUNCTION mode of the 2606 and the 500 ms averaging time of the "RMS Slow" METER FUNCTION. The effective averaging times available using other settings of the WRITING SPEED CONTROL are given in Fig. 6.2.

5. Set the LOWER LIMITING FREQUENCY control of the Recorder as indicated in Fig. 6.4. LOWER LIMITING FREQUENCY selection should be made on the basis of stable operation of the Recorder with the WRITING SPEED setting selected in item 4.

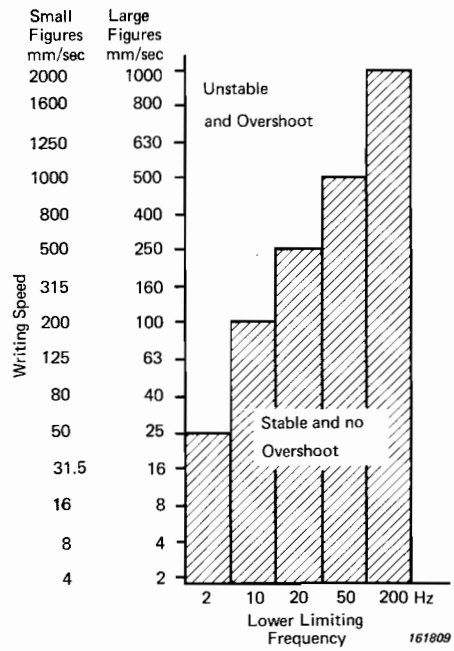

Fig. 6.4. Relation between LOWER LIMITING FREQUENCY setting and WRITING SPEED setting for stable operation of the 2305 or 2307 Level Recorders

6. Calibrate the 2606 for sound, vibration or voltage measurements as described under the various sections for calibration in Chapter 3.

7. Keeping the control settings used for calibration of the 2606, adjust the INPUT ATTENUATOR and INPUT POTENTIOMETER of the Level Recorder so that its pen deflection corresponds to the meter deflection on the 2606 when the calibration source is connected. To do this proceed as follows:

SOUND. When a Pistonphone (124 dB) or Sound Level Calibrator (94 dB) is used for calibration, set the Recorder's pen deflection to 4 dB above one of the thick lines on the recording paper. For evaluation of recorded measurements the thick line will correspond to the SPL value given by the RANGE INDICATOR lamps of the 2606.

When the 50 mV reference source of the 2606 is used for calibration, adjust the meter deflection of the 2606 to the correct microphone sensitivity on the "Micr. Sens." scale of the meter and note the value of the corresponding deflection on the dB scale. Set the Recorder's pen to this value above one of the thick lines on the recording paper. For evaluation of recorded measurements the thick line will correspond to the SPL value given by the RANGE INDICATOR lamps of the 2606.

VIBRATION. When the Vibration Calibrator or the ACCELEROMETER CALIBRATOR is used, either the "RMS" or "Peak" modes of the Recorder's RECTIFIER RESPONSE switch may be selected. If the RMS mode is selected then set the Recorder's pen to 3 dB below one of the thick lines on the recording paper or if the Peak mode is used to one of the thick lines. For evaluation of recorded measurements the thick line will correspond to the g level given by the RANGE INDICATOR lamps of the 2606.

If the 50 mV reference source of the 2606 is used, read off the dB value below full scale to which the meter deflection of the 2606 is set for calibration and set the Recorder's pen to this value below one of thick lines on the recording paper. For evaluation of recorded data the thick line will correspond to the g level given by the RANGE INDICATOR lamps of the 2606.

VOLTAGE. When the 50 mV reference source of the 2606 is used, set the Recorder's pen deflection to 6 dB below one of the thick lines on the recording paper. For evaluation of recorded data the thick line will correspond to the voltage level given by the RANGE INDICATOR lamps of the 2606.

8. Remove the calibration source and if not already connected apply the signal to be recorded to the appropriate INPUT socket of the 2606.

9. Without readjusting the INPUT ATTENUATOR and INPUT POTENTIOMETER on the Level Recorder adjust the INPUT and OUTPUT SECTION ATTENUATORS of the 2606 to obtain a suitable pen deflection on the Recorder. Where possible keep the OUTPUT SECTION ATTENUATOR in the "x 1" position.

10. To start the recording press the Recorder's PAPER DRIVE "Start" button. To stop the recording press the Recorder's PAPER DRIVE "Stop" button.

5.1.3. DC Recording

Typewriter, teleprinter and similar noise cannot be regarded as continuous. If an AC recording of such noise is made then the recording will be found to fluctuate too much and give too low a reading. For an accurate recording to be made it is better to record from the DC Output of the 2606 with its "Impulse" METER FUNCTION mode selected, as the controlled time constants of the RMS and Hold Circuits of the 2606 will provide more precise averaging of signal fluctuations over the entire dynamic range of the DC output (see Fig.4.11). These same advantages may also be obtained for recording continuous signals using the DC output. However, in this case either the "RMS Fast" or "RMS Slow" METER FUNCTION modes should be selected.

To record from the DC output of the 2606 the procedure is similar to that of section 6.1.2 except for the following amendments. The item numbers of the amendments correspond to those used in section 6.1.2.

1. With the OUTPUT MODE switch of the 2606 set to "DC", connect the RECORDER output socket of the 2606 to the INPUT socket of the 2307 Level Recorder.

3. Set the Level Recorder controls:

POTENTIOMETER RANGE	"50 dB"
RECTIFIER RESPONSE	"DC"
PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	as required
PEN DRIVE	"On"
POWER	"On"

4. For DC recording averaging is performed by the internal time constants of the 2606. These are selected using the METER FUNCTION switch which should be set to "Impulse" for measurement of non-continuous sounds. "RMS Fast" for measurement of continuous sound, vibration and voltage signals with components down to 15 Hz, or to "RMS Slow" for continuous sound, vibration and voltage signals with components down to 3 Hz. Apart from recording the suggested METER FUNCTION setting should also be used when calibrating the recording arrangement. With the "Impulse" mode the internal averaging and decay time constants used are 35 ms and 3 s respectively, whilst the internal averaging time constants used in the "RMS Fast" and "RMS Slow" modes are 100 ms and 500 ms respectively.

5. Since for DC recording averaging is performed by the internal time constants of the 2606, the Recorder's WRITING SPEED selector should be set to "1000 mm/s" to prevent the averaging effect of the Recorder's writing system influencing the recording. Also any LOWER LIMITING FREQUENCY setting (except 200 Hz with the 2305) may be used as with DC operation neither the Recorder's stability nor low frequency response are affected by the setting of this control.

For evaluation of DC recorded data the dynamic range of the DC output of the 2606 must be considered. For most settings of the INPUT AND OUTPUT SECTION ATTENUATORS the dynamic range available (see section 4.7) is 31 dB and therefore when DC recordings are made with a Level Recorder fitted with a 50 dB Range Potentiometer only part of the recording range will be linear. When the 2606 and the Level Recorder used are calibrated according to items 6 and 7 of section 5.1.2. the linear part of the recording range will extend 6 dB above and 25 dB below the thick line on the recording paper corresponding to the sound pressure, vibration or voltage level for full scale meter deflection on the 2606. Outside this region the recording will be non-linear and therefore cannot be used to give meaningful results.

6.2. FREQUENCY ANALYSIS

In the majority of noise and vibration investigations the signal to be measured will be complex and therefore more meaningful results can be obtained by frequency analysis. For this purpose the 2606 may be used for octave and third octave analysis with the 1614 or 1615 Filter Sets* or for constant bandwidth analysis with the 2020 Heterodyne Slave Filter.

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* The 1612 Filter Set may also be used for octave and third octave analysis with the 2606. For powering the 1612 a + 20 V supply line is available at the OVERLOAD socket of the 2606. For connections see section 3.9.2.

6.2.1. Octave and Third Octave Analysis - Filter Sets Type 1614 or 1615

A measurement arrangement whereby an octave or third octave analysis may be made using a 1614 or 1615 Filter Set with the 2606 is shown in Fig.6.5. The 1614 Filter Set contains 50 contiguous band pass third octave filters with centre frequencies ranging from 2 Hz up to 160 kHz, whilst the 1615 Filter Set contains 30 third octave filters with centre frequencies ranging from 25 Hz to 20 kHz. Both Filter Sets may be switched so that their third octave filters are paralleled to give a set of octave filters.

For analysis, connection of the Filter Sets is made via the EXT. FILTER INPUT and EXT. FILTER OUTPUT sockets of the 2606 when the "Ext." filter mode of the 2606 is selected using the FILTER push-buttons. With a 2305 or 2307 Level Recorder included in the set up the filter shift pulses generated by the Level Recorder may be used to remotely switch the third octave filters of the Filter Set via the Control Cable AQ 0019. In this way synchronization is obtained between the movement of the Recorder's frequency calibrated paper and the switching of the filters, thus enabling an analysis to be recorded automatically.

For further information on octave and third octave analysis using the 1614 or 1615 Filter Sets, consult the 1614, 1615 Instruction Manual.

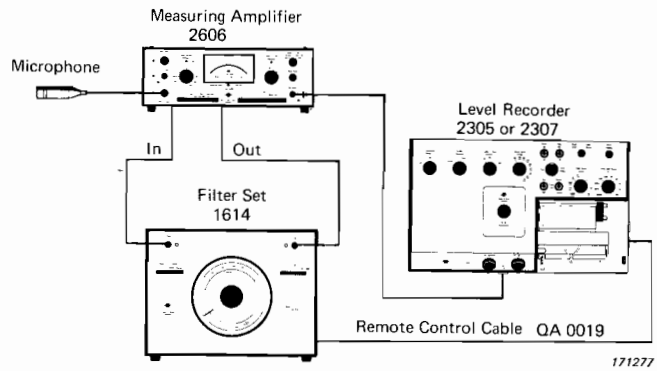

Fig.6.5. Octave and third octave analysis using the 1614 or 1615 Filter Sets with the 2606

6.2.2. Constant Bandwidth Analysis - 2020 Heterodyne Slave Filter

The 2020 has four selectable bandwidths of 3,16 Hz, 10 Hz, 31,6 Hz and 100 Hz. Its centre frequency may be tuned over the 20 Hz to 20 kHz range using the high frequency control signals provided by a 1022 Beat Frequency Oscillator or 1024 Sine Random Generator. For constant bandwidth analysis using the 2020 Slave Filter with the 2606 an instrument arrangement is shown in Fig.6.6.

For recording a constant bandwidth analysis using a 2305 or 2307 Level Recorder, synchronization between the centre frequency of the 2020 and the movement of the Recorder's frequency calibrated paper can be obtained with the Flexible Shaft UB 0041 connected between the Recorder and the 1022 or 1024. This will automatically tune the 1022 or 1024 which in turn will automatically tune the centre frequency of the 2020.

For further information on constant bandwidth analysis using the 2020, consult the 2020 Instruction Manual.

6.3. MEASUREMENT OF POWER SPECTRAL DENSITY

The arrangement shown in Fig.6.6 may also be used to make PSD (Power Spectral Density) measurements. For this purpose the 2606 measures the RMS value of the filtered output signal from the 2020 Heterodyne Slave Filter and then squares the signal to obtain the mean square value using its PSD meter scale SA 0046. The scale is calibrated in V^2/Hz enabling the PSD to be read directly from the 2606 when the $1/\sqrt{B}$ BANDWIDTH COMPENSATION mode of the 2020 is selected.

For further information on power spectral density measurements the B & K Booklet "Frequency Analysis and Power Spectral Density Measurements" is available on request.

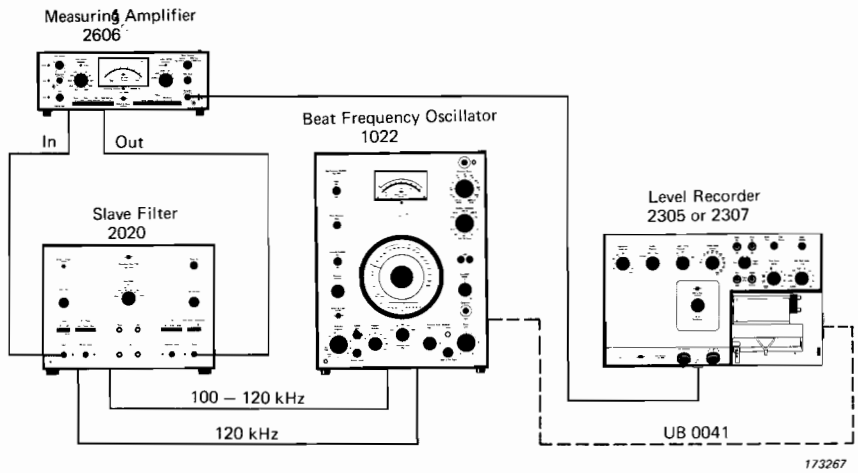

Fig.6.6 Constant bandwidth analysis using the 2020 Heterodyne Slave Filter with the 2606

6.4. MEASUREMENT OF ABSORPTION COEFFICIENT

The use of the 2606 together with the 4002 Standing Wave Apparatus and a 1022 BFO or 1024 Sine Random Generator as shown in Fig.6.7, permits the sound absorption coefficients for various materials to be read directly from the 2606 meter scale SA 0045. The scale has 3 ranges, 0 — 100%, 0 — 70% and 0 — 30%.

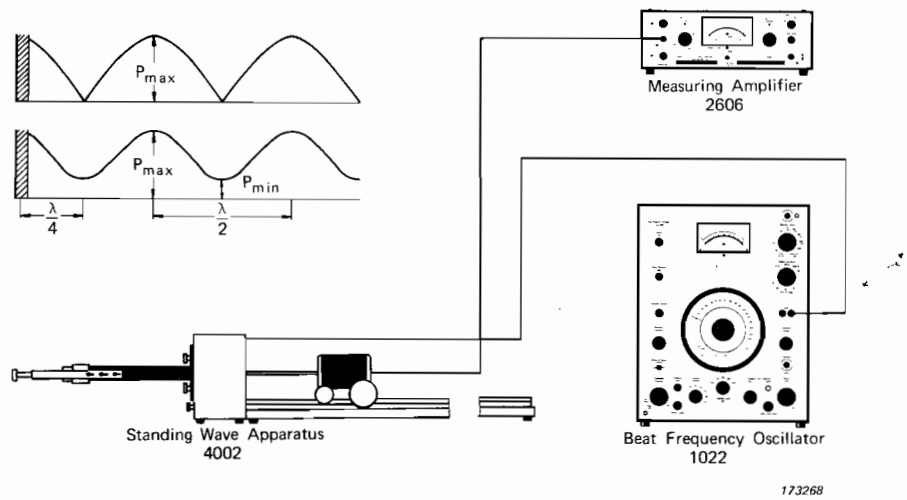

Fig.6.7. Absorption measurements using the Standing Wave Apparatus 4002

To take a reading, position the microphone trolley of the 4002 to a point of maximum sound pressure and adjust the Gain Control to give full scale meter deflection (100%). The microphone is then moved to a position of minimum sound pressure and the absorption coefficient read off the meter scale. By increasing the gain of the 2606 by 10 or 20 dB the minimum reading can be taken from the 0 — 70% or 0 — 30% ranges of the meter scale.

Further information on the operation of the Standing Wave Apparatus can be found in its instruction manual.

6.5. USE AS A COMPRESSOR AMPLIFIER

In many measurement systems where a sweep frequency generator is employed to drive an electro-mechanical transducer, it is often important to ensure that the output level (sound pressure, vibration level etc.) remains constant with frequency. For instance, in vibration test work where a signal generator is used to drive a shaker, the vibration level produced by the shaker is not only controlled by the amount of electrical drive produced by the generator, but also by the frequency response of the shaker. Mechanical resonances both in the shaker and in the specimen under test can produce exceedingly high vibration levels for a very small amount of drive and this could damage the shaker as well as the specimen.

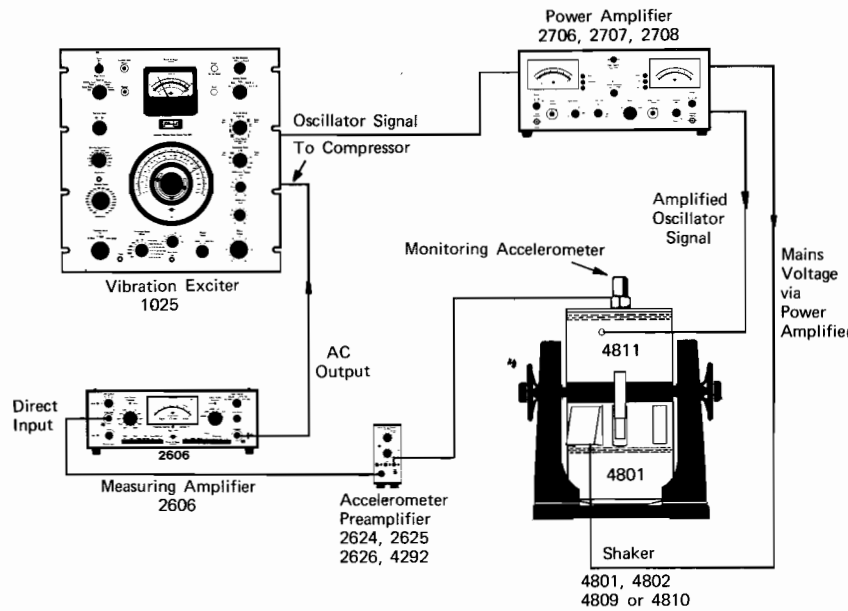

Fig.6.8. Instrument arrangement for vibration measurements using the 2606 as a compressor amplifier

To help overcome this problem the signal generators and vibration exciters produced by B & K include a compressor facility. The compressor, when used together with a suitable amplifier such as the 2606 and an appropriate measurement transducer, monitors the output of the transducer and provides the necessary excitation to keep its output constant by automatically regulating the output of the generator. The rate at which the compressor may follow a frequency sweep is controlled by the compressor speed selector of the generator.

Two typical instrument arrangements showing the use of the 2606 as a compressor amplifier for vibration testing and for sound transducer measurements are shown in Fig.6.8 and 6.9 respectively.

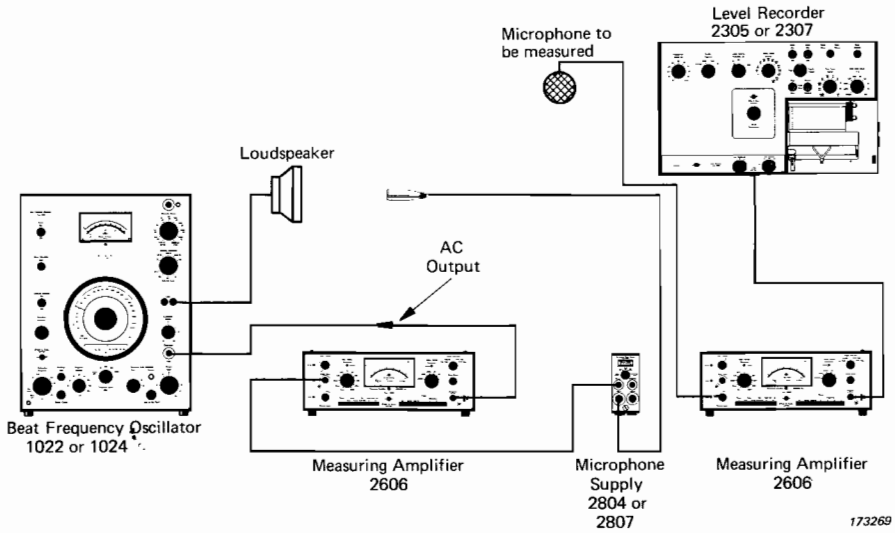

Fig.6.9. Instrument arrangement for measuring the frequency response of a microphone using the 2606 as a compressor amplifier

To set up a compressor loop using the 2606 as a compressor amplifier, proceed as follows:

1. Connect the output of the signal generator to the electromechanical transducer (loudspeaker, shaker etc.), which is to be used to provide the necessary excitation force for measurements. If necessary connect the transducer via a power amplifier.

2. If the transducer providing the excitation force is a shaker then mount an accelerometer to the shaker table and connect the output of the accelerometer to the Direct Input of the 2606 via an accelerometer preamplifier. To connect a miniature accelerometer cable to the 2606 a Micro-Dot adaptor (B & K Type JP 0028) is available on separate order.

   If the transducer providing the excitation force is a loudspeaker then connect a microphone and preamplifier to the "Preamp." input of the 2606. To prevent delay in the function of the signal generator's compressor due to the speed at which sound is propagated, the microphone should placed as near as possible to the loudspeaker and should be in a position that will not interfere with the sound field radiated by the loudspeaker.

3. Set the OUTPUT MODE switch of the 2606 to "AC" and connect the RECORDER output socket of the instrument to the COMPRESSOR INPUT of the Generator.

4. With the COMPRESSOR SPEED control of the generator set to "OFF" set the generator to a frequency within the range of the excitation transducer and adjust the output level of the generator to produce an excitation level which is higher than that required for measurements.

5. Adjust the INPUT AND OUTPUT SECTION ATTENUATORS of the 2606 to obtain a suitable deflection on its indicating meter.

6. With the compressor voltage control of the generator turned to maximum (fully clockwise), select a suitable compressor speed (see Table 6.1) for the lowest sweep frequency to be used for measurements and set the COMPRESSOR SPEED control of the generator to this value.

Lowest Frequency of chosen sweep range Hz	COMPRESSOR SPEED dB/s
5	10
30	30
100	100
300	300
1000	1000
3000	3000

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Table 6.1. Compressor speed setting as a function of lowest sweep frequency for a B & K signal generator or vibration exciter

7. Adjust the COMPRESSOR VOLTAGE control of the generator so that the 2606 indicates the required excitation level to be used for measurements. To check that the compressor system is properly set up, gradually turn up the generator's output voltage control to its maximum. There should be no change in the excitation level.

For further information on the compressor facility of B & K signal generators and vibration generators, refer to the relevant instruction manuals for these instruments.

BRÜEL & KJÆR instruments cover the whole field of sound and vibration measurements. The main groups are:

ACOUSTICAL MEASUREMENTS
Condenser Microphones
Piezoelectric Microphones
Microphone Preamplifiers
Sound Level Meters
Precision Sound Level Meters
Impulse Sound Level Meters
Standing Wave Apparatus
Noise Limit Indicators
Microphone Calibrators

ACOUSTICAL RESPONSE TESTING
Beat Frequency Oscillators
Random Noise Generators
Sine-Random Generators
Artificial Voices
Artificial Ears
Artificial Mastoids
Hearing Aid Test Boxes
Audiometer Calibrators
Telephone Measuring Equipment
Audio Reproduction Test Equipment
Tapping Machines
Turntables

VIBRATION MEASUREMENTS
Accelerometers
Force Transducers
Impedance Heads
Accelerometer Preamplifiers
Vibration Meters
Accelerometer Calibrators
Magnetic Transducers
Capacitive Transducers
Complex Modulus Apparatus

VIBRATION TESTING
Exciter Controls — Sine
Exciter Controls — Sine — Random
Exciter Equalizers, Random or Shock
Exciters
Power Amplifiers
Programmer Units
Stroboscopes

STRAIN MEASUREMENTS
Strain Gauge Apparatus
Multi-point Panels
Automatic Selectors

MEASUREMENT AND ANALYSIS
Voltmeters and Ohmmeters
Deviation Bridges
Measuring Amplifiers
Band-Pass Filter Sets
Frequency Analyzers
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RECORDING
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Tape Recorders

DIGITAL EQUIPMENT
Digital Encoder
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Tape Readers

BRÜEL & KJÆR DK-2850 Nærum, Denmark. Teleph.: (01) 80 05 00. Cable: BRUKJA, Copenhagen. Telex: 15316

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